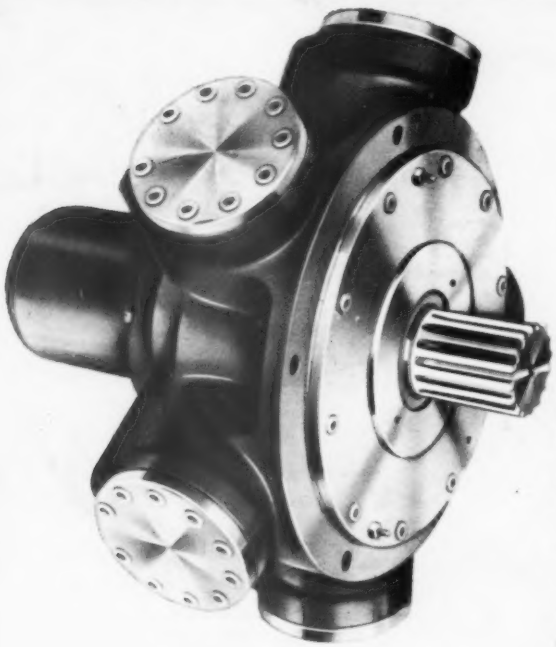
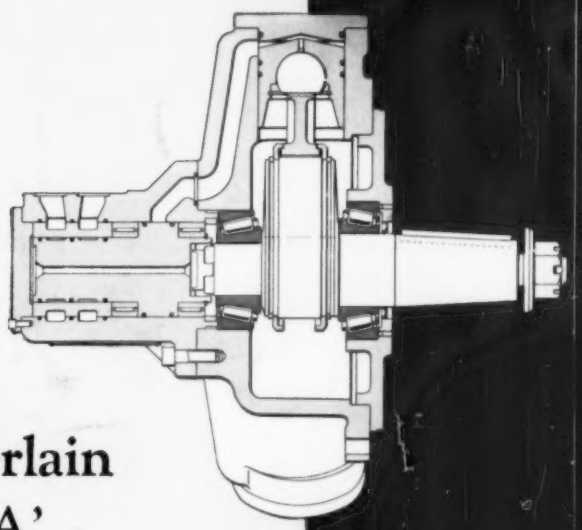
Mechanical World

AND ENGINEERING RECORD

Monthly: Two Shillings and Sixpence | Established 1876 | SEPTEMBER, 1960





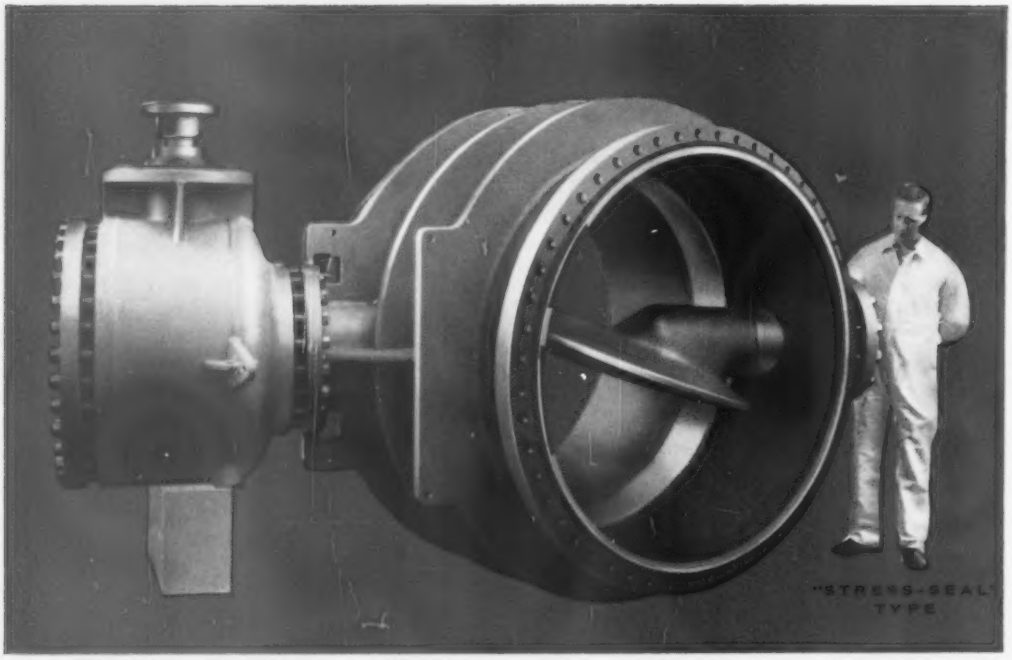
On the Chamberlain 'STAFFA' hydraulic motor

These hydraulic radial motors, made by Chamberlain Industries Limited, of London, are made in two models, intended for use with applications ranging from coal conveyors to plastic extrusion presses, where their flexibility is invaluable. The motors normally operate at 2,000 p.s.i., but are capable of operating at 3,000 p.s.i. for starting and peak loads.

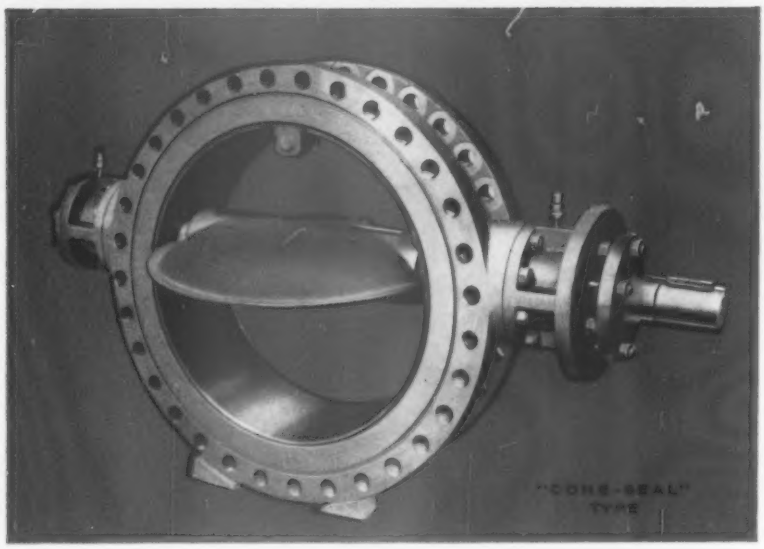
Full torque is developed at speeds from 1 to 100 r.p.m.; the Mark IV five-cylinder model has a maximum output torque of 4,750 lb. ft. and the Mark V seven-cylinder model 6,650 lb. ft., both at 2,000 p.s.i.

The connecting rods have 'slipper' big-end bearings riding upon the eccentric main shaft; this runs in Timken tapered roller bearings.

British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Brazil, Canada, France and U.S.A.



REACTOR GAS VALVES



Specially developed for high temperature gas duct service, Blakeborough "Cone-Seal" and "Stress-Seal" Butterfly valves have aroused particular interest in the nuclear field. The "Cone-Seal" construction is applicable to sizes up to 42 in. bore; the "Stress-Seal" from 36 in. upwards. Both give tight closure, or shut-off to very fine leakage tolerances, even under severe thermal shock conditions. They are being supplied for main duct isolating duty on the following power reactors :-

BERKELEY	"Stress-Seal" type. Thirty-two 60 in. bore. Design conditions : 137 psig. and 716° F.
TOKAI MURA	"Stress-Seal" type. Eight 66 in. bore. Design conditions : 230 psig. and 797° F.
WINDSCALE	(AGR). "Cone-Seal" type. Eight 24 in. bore. Design conditions : 300 psig. and 1067° F.
TRAWSFYNYDD	Twelve 66 in. bore. Main gas duct throttle service. Twelve 42 in. bore. By-pass service. Also : Throttle type butterfly valves (without shut-off), as at present in hand.

BLAKEBOROUGH

J. BLAKEBOROUGH & SONS LTD BRIGHOUSE ENGLAND

GAMAX

One of the hundreds of Gamax Gear Units installed in the factory of W. D. & H. O. Wills.

THE GREAT LITTLE Gear Unit

gives smooth, efficient service in light industry

For packaging cigarettes and for almost any other light industrial tasks requiring a range of ½ to 1½ max. H.P. (18–896 r.p.m. output speed) these compact Gamax Gear Units excel. Incorporating straight line drive with high quality Durangus non-metallic planet pinions they provide really silent, vibration-free operation . . . *and because conventional oilbath lubrication is completely dispensed with, all fear of leakage or contamination is eliminated.*

The sealed bearing assembly is prepacked with grease to ensure at least two years trouble free running under normal conditions . . . and these compact units can be mounted at *any* angle without in any way impairing their efficiency.

Competitive in price, these outstanding gear units are available to give efficient, quiet and trouble-free service in any light industrial application.

ALSO IN REGULAR PRODUCTION ARE:—

Spur and Helical Gears up to 78″ diameter.

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Worm Gears up to 24″ centres.

Bevel Gears up to 5 ft. diameter.

Profile Ground Spur, Helical and Worm Gears.

Durangus and Peak Non-metallic Silent Gears.

Rawhide Silent Pinions.

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GEAR DIVISION
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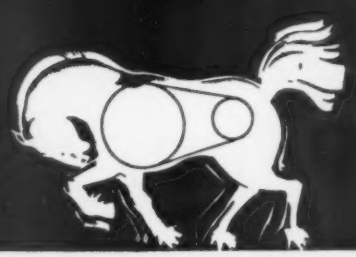
USE IT WHERE PRESENT DRIVE IS OVERLOADED.
USE IT WHERE MORE POWER IS REQUIRED IN THE SAME DRIVING SPACE.
USE IT WHERE V-BELT LIFE IS LIMITED.



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TURNERS POLY-V (TRADE MARK) DRIVE

YOU can improve your power transmission applications
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Advantages of **THE "POLY-V" DRIVE**

- **"POLY-V" Belts transmit the same horse power as conventional V-belts on very much narrower pulleys.**
- **The unique design of "POLY-V" Drives reduce pulley widths to the minimum, resulting in maximum saving in space and reduction in pulley weight and costs.**
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- **Constant pitch diameters at all loads are maintained on "POLY-V" Drives.**
- **"POLY-V" Drives ensure minimum vibration and cooler running.**
- **"POLY-V" Drives provide greater interchangeability of belts and pulleys because there are only two belt cross sections instead of five for multiple V-belt drives.**
- **Longer lives of belts and pulleys are obtained on "POLY-V" Drives.**
- **"POLY-V" Belts are heat and oil resistant.**
- **"POLY-V" Belts, due to their small rib section, can be used in place of flat belts by cutting grooves in existing pulleys. "POLY-V" Drive conversions on stepped pulleys are particularly successful.**
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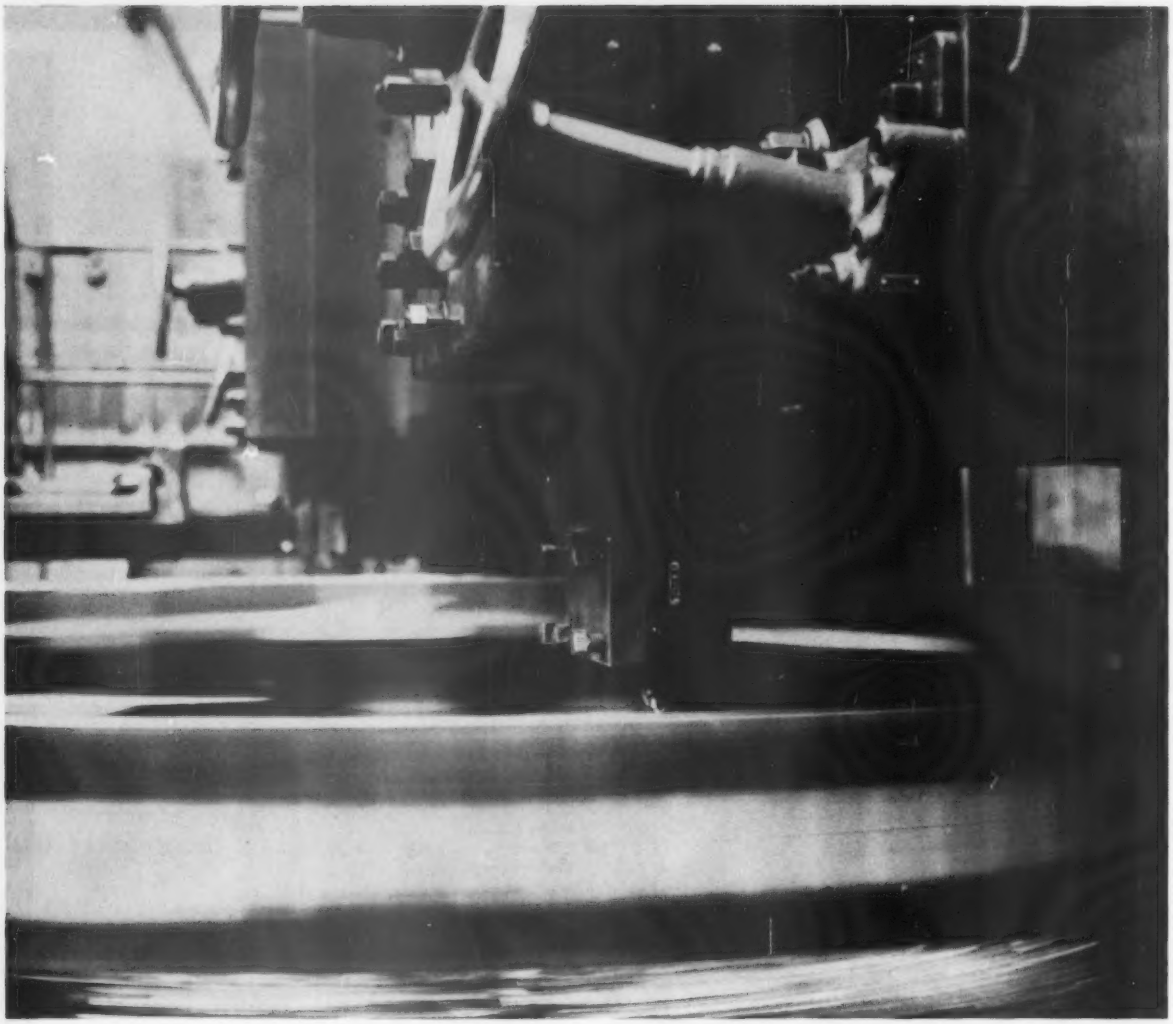

turning out

the big stuff is nothing new for Crofts. They've been doing it for years. Really big stuff, too. Spur and helical gears up to 185" diameter, 37" face width, 5" CP—that's the way Crofts talk.

Here's a spur in Crofts fitting shop being turned into a powerful help to somebody, and it could be you. When it comes to big stuff (casting, machining and cutting), call Crofts—they've been doing it for years.

* *Customer's blanks can be cut and gears manufactured to special order, but remember Crofts STOCK RANGE includes Spur and Mitre Gear Drives up to 70 hp and Bevel Gears up to 44 hp. We also produce Internal Gears, Racks and Pinions, Worms and Wheels, Spiral Bevels and Spiral Mitres. And Crofts can handle Steel Castings up to 8 tons! Publication 159 tells the whole story—your copy's waiting.*

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Helical gear units are available in standard sizes from 10 to 4,000 h.p. for input speeds up to 3,000 r.p.m. The range of ratios is from 2:1 to 7:1 dependent on horse-power. Ball and roller bearings are fitted throughout the range; no external lubrication is required.

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set a fresh standard of high efficiency filtration for

AIR—WATER—PETROL, DIESEL AND FUEL OILS— LUBRICATING, HYDRAULIC AND OTHER FLUIDS

Tecalemit Ribbon Filter Elements

Simple construction—Low cost—High flow rate—Easy to clean

The elements are formed of resin impregnated cellulose ribbon, wound helically and electrically fused into an open-ended cylinder. Innumerable microscopic orifices between the ribbons allow a very high flow rate, while retaining impurities on the outside or inside surfaces, according to direction of flow.

The standard range of diameters (in any length) covers most applications, and no other filtration material can so readily be adapted to individual requirements for filters, strainers, breathers or separators. Never before has such fine filtration been possible at such low cost and with such flexibility in use.

Tecalemit Ribbon Elements filter to maximum purity

Tecalemit Air Breather Filters

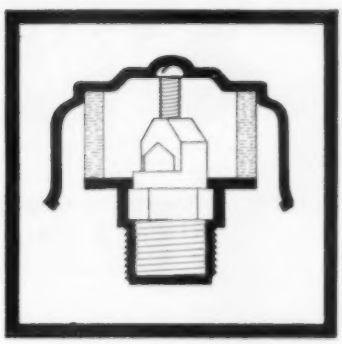
(Incorporating Tecalemit Ribbon Filter Elements)

Cheapest—Most efficient—Cleanest to service

Tecalemit Breathers act as ventilators to provide a free flow of clean air to hydraulic fluid, fuel and oil reservoirs. They give positive protection from airborne contamination to tanks, pumps, valves, cylinder and other engine components.

Of the standard types, two are breathers with screwed bodies, and the third is a combined clip-on assembly of breather and filter cap. All are fitted with Tecalemit Ribbon Filter Elements.

Tecalemit Breathers provide pure air cheaply and efficiently



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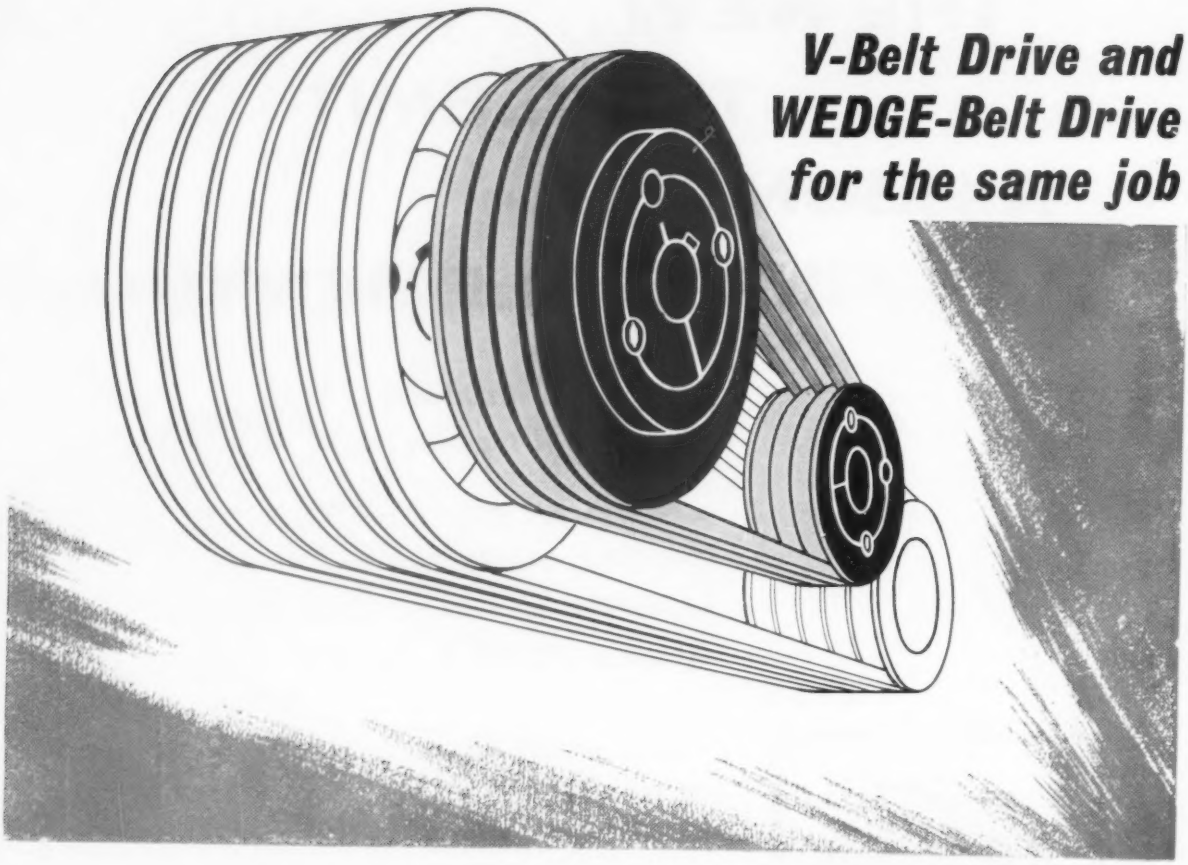

V-Belt Drive and WEDGE-Belt Drive for the same job

THE GREATEST ADVANCE IN DRIVE DESIGN FOR 30 YEARS

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WEDGE-BELT DRIVES

MADE ONLY BY **Fenner**

THE LARGEST MAKERS OF V-BELT

Fenner SpacesaVer Wedge-Belt Drives are

SLIMMER, LIGHTER, SHORTER, CHEAPER

- Width and weight now reduced by a half, and cost by at least a fifth, without loss of strength or durability.
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- Stocks of Wedge-Belts and pulleys available in all our 19 branches.
- The new SpacesaVer Wedge-Belt drives are made solely by Fenner, the only company in the world to make both V-Belts and pulleys.

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	Wedge-Belt	3·15	5·60	$1\frac{1}{2}$	3 Alpha 280	7·1	£5 · 3 · 8	10·6
	SAVING	**16%**	**12%**	**54%**	—	**5%**	**19%**	**36%**
25 H.P.	V-Belt	$6\frac{1}{2}$	$12\frac{1}{2}$	$5\frac{7}{32}$	6—B65	18·7	£17 · 0 · 7	66·8
	Wedge-Belt	5·3	10·6	$2\frac{33}{32}$	6 Alpha 560	15·3	£11 · 11 · 6	36·2
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50 H.P.	V-Belt	$8\frac{3}{4}$	$24\frac{3}{4}$	$6\frac{13}{16}$	6—C112	30·5	£45 · 0 · 1	258
	Wedge-Belt	7·1	21·2	$3\frac{3}{4}$	5 Beta 1000	26·9	£32 · 19 · 9	138
	SAVING	**19%**	**14%**	**45%**	—	**12%**	**26%**	**46%**
100 H.P.	V-Belt	$10\frac{3}{4}$	$42\frac{3}{4}$	$8\frac{15}{16}$	8—C180	47·2	£86 · 2 · 4	530
	Wedge-Belt	9·0	37·5	$4\frac{7}{16}$	6 Beta 1600	41·1	£63 · 15 · 2	340
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Catalogue 135/20 details drives up to 200 h.p. Send for it **NOW!**

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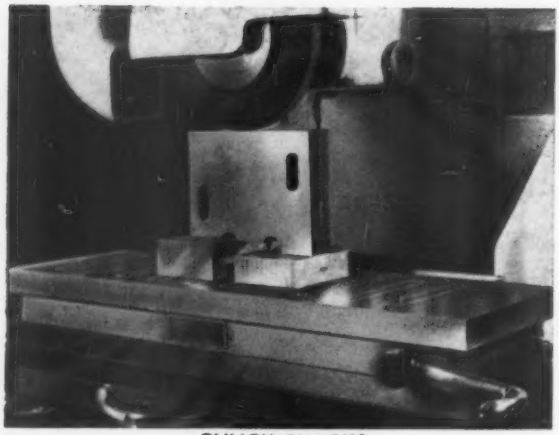

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the complete range of permanent magnet chuck accessories

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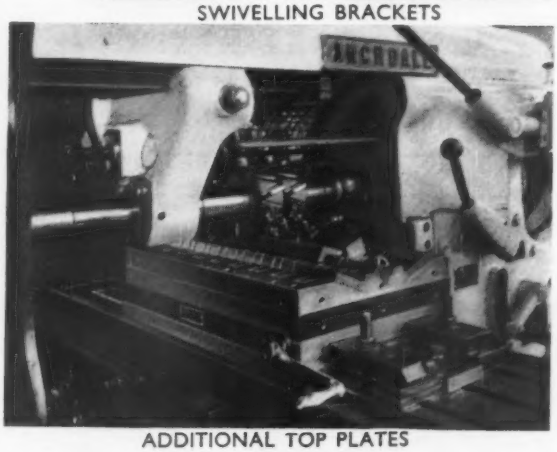

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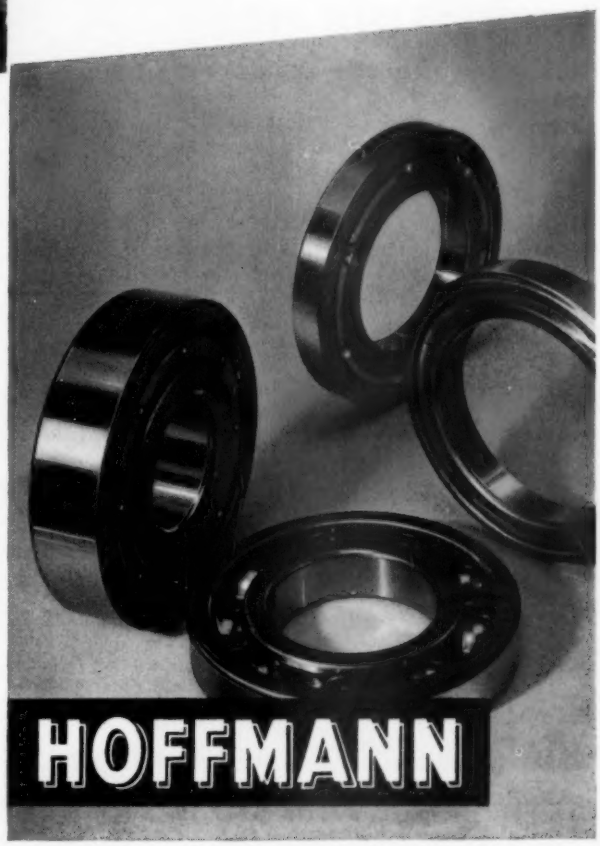

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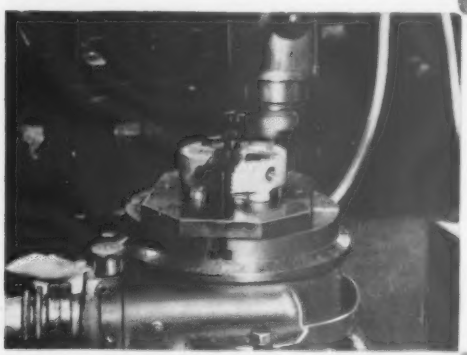

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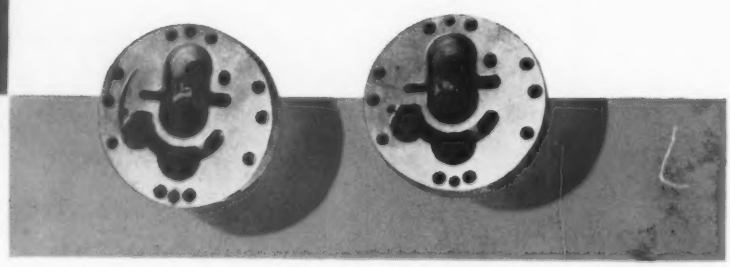

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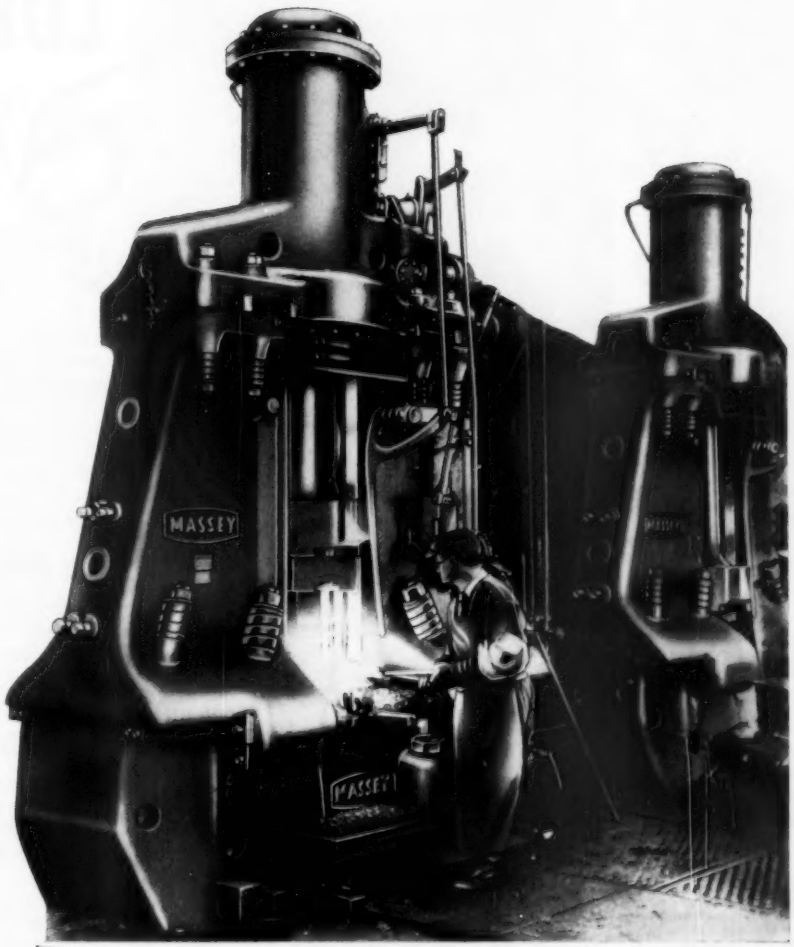

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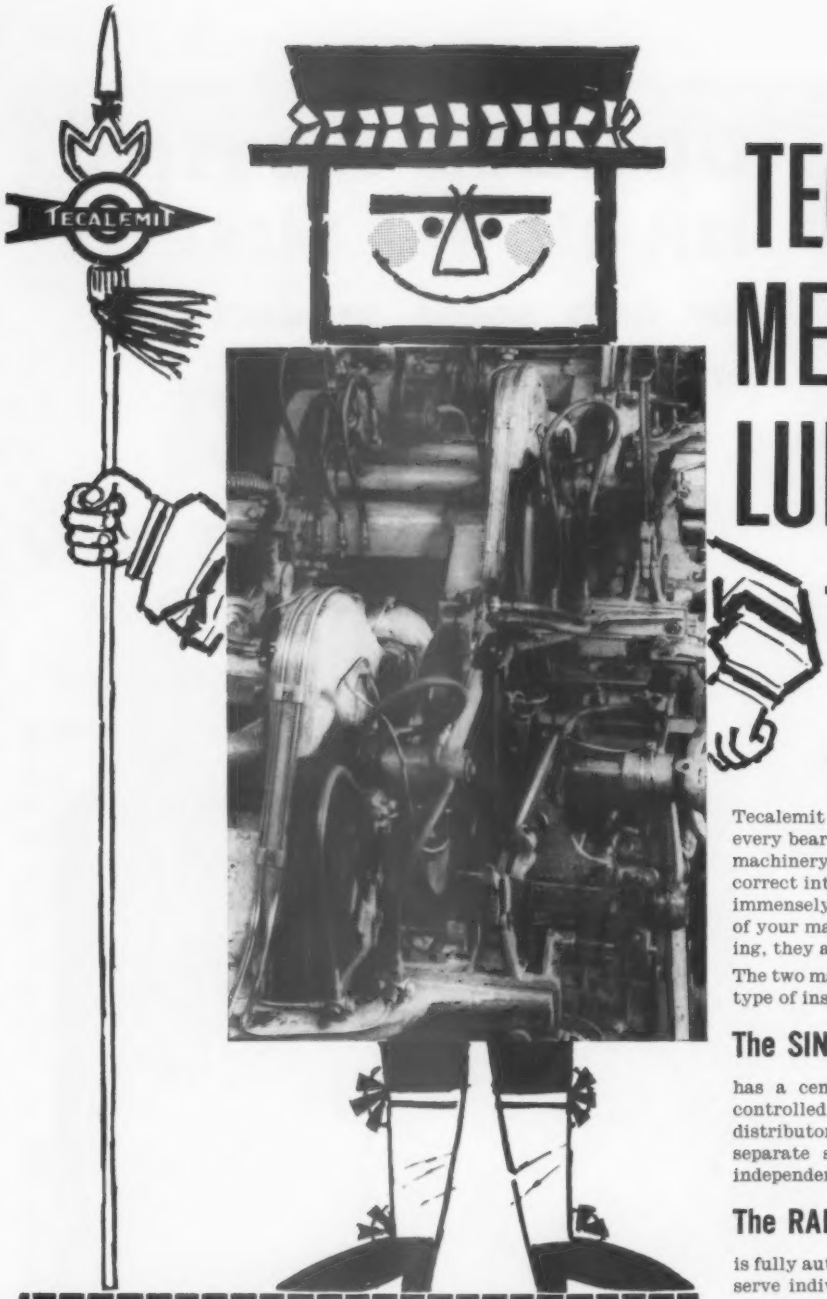

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Tecalemit Mechanical Greasing Systems guard every bearing. Fitted into new designs or existing machinery, they ensure correct greasing at the correct intervals, eliminate neglect and error, and immensely increase the working life and efficiency of your machines. And by cutting out hand greasing, they add much to works safety.

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The SINGLE-LINE SYSTEM

has a central pump—fully automatic, operator controlled, or hand operated—and a single main distributor line, feeding each bearing through a separate single-line injector, each of which is independently regulated.

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is fully automatic, and uses 19 miniature pumps to serve individual bearings. Each pump's output is pre-regulated. The unit can be driven from the machine it serves, or supplied with its own electric motor.

Tecalemit Mechanical Lubrication can solve your problems and speed your production.

To Tecalemit Ltd. (Sales MEW) Plymouth, Devon

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TECALEMIT

—the Authority on Lubrication

Tecalemit Limited (Sales MEW), Plymouth, Devon.

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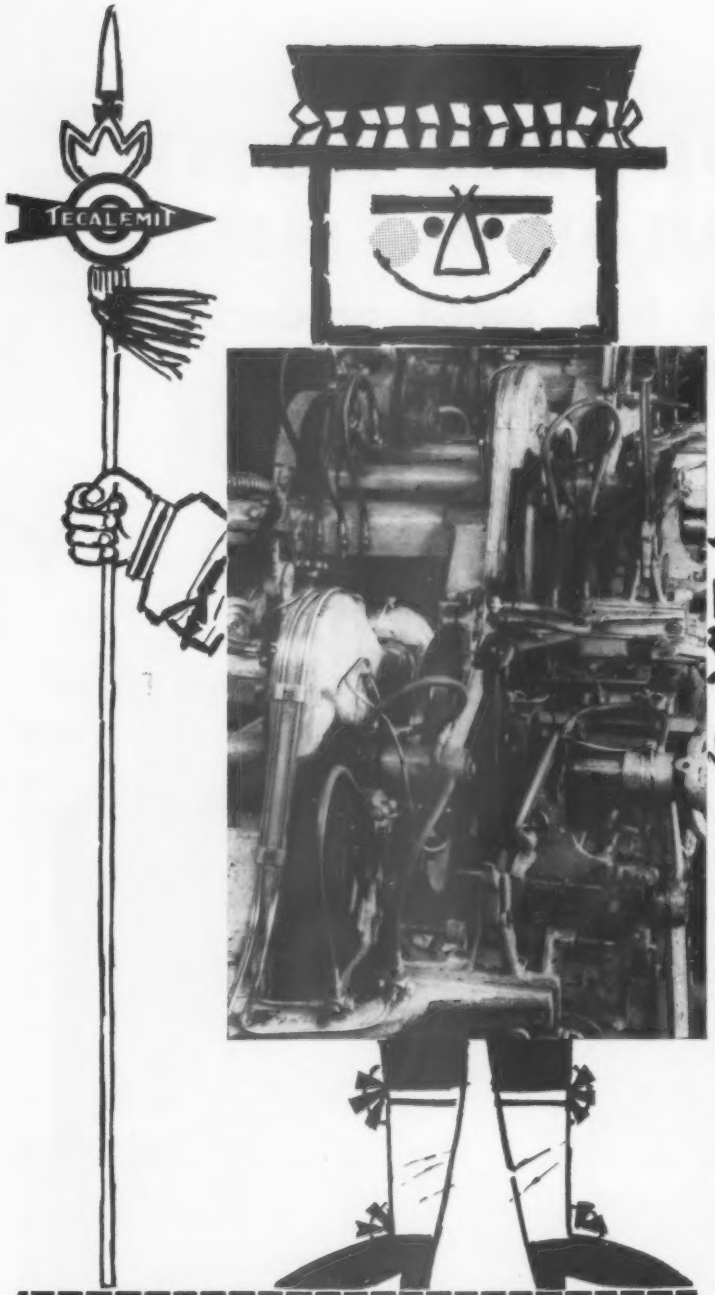

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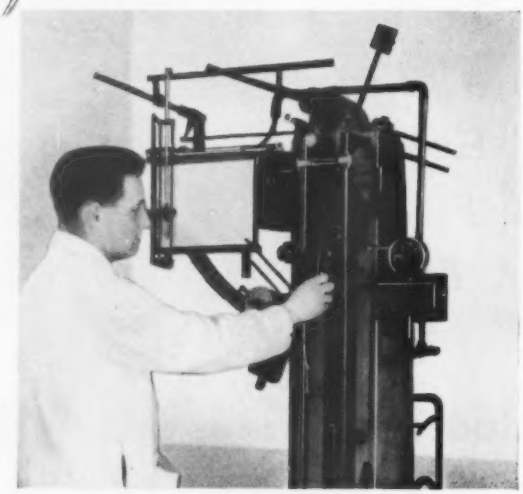
✻ *we think in terms of tomorrow*



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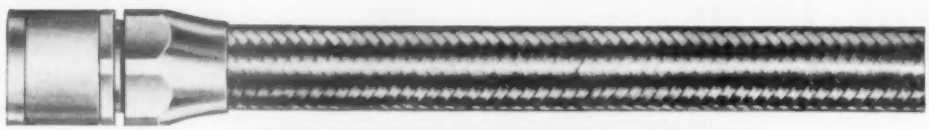

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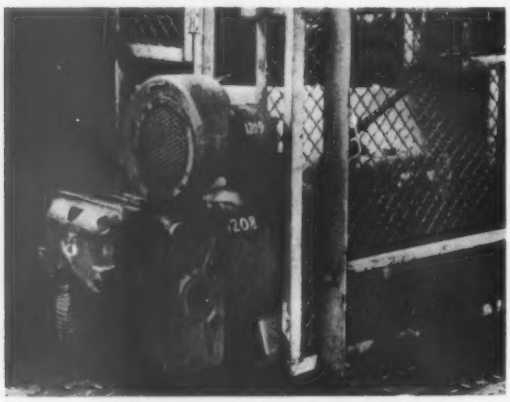

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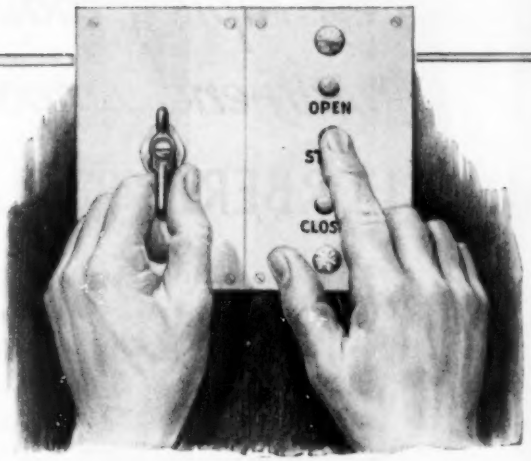

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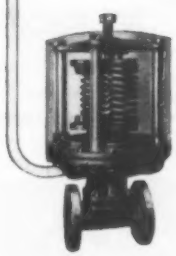

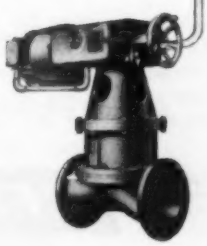

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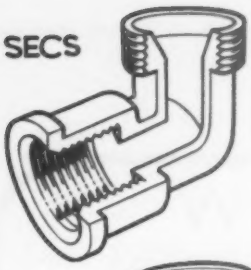

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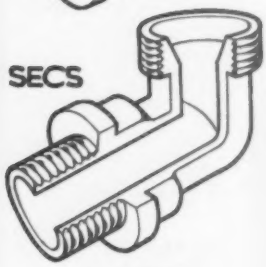

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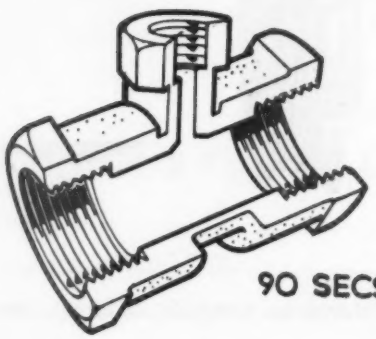

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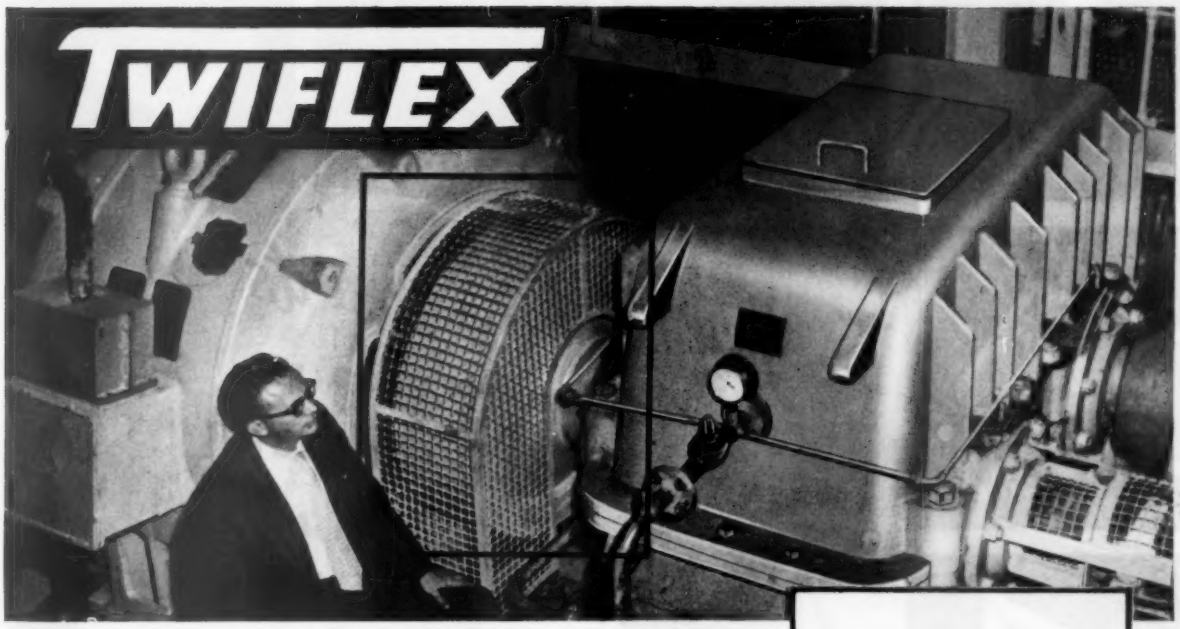

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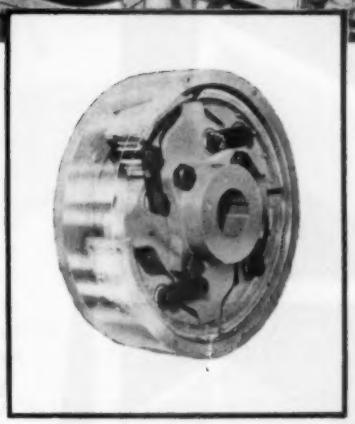

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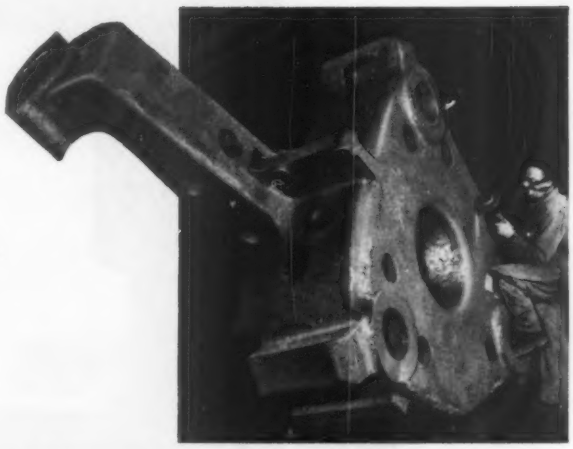

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Mechanical World

AND ENGINEERING RECORD

Vol. 140 SEPTEMBER, 1960 Number 3494

Contents

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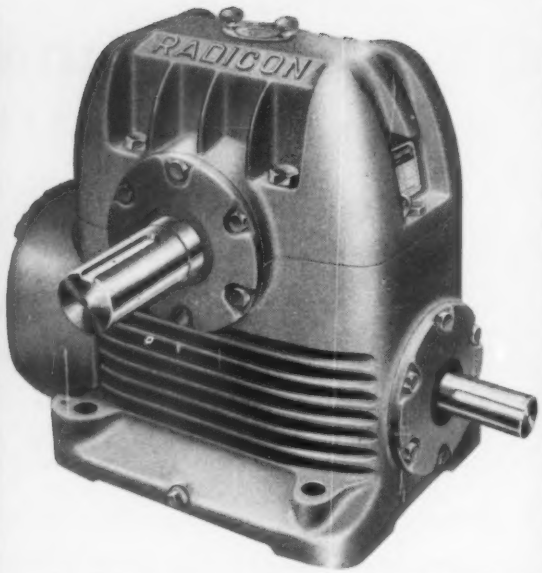

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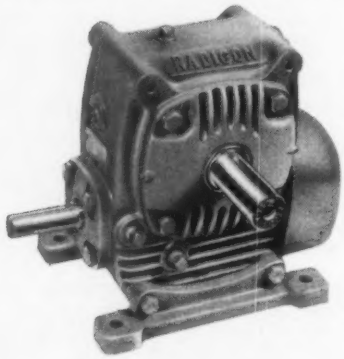

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Research Comparator

WITH the continuing increase in the number of grant-aided research associations (the number is now more than fifty) the range of subject matter investigated must be getting quite wide. Indeed the report of the Department of Scientific and Industrial Research indicates that this is so—the work ranging in scale from shipbuilding to thin films, and in kind from the fatigue of metals to optical systems.

Each association has its own field and deals with the fundamental and applied problems which arise in, or from consideration of, the industry which it serves. The work is scientific in method and basis, and it is this more than anything which is the common link among the associations. The body of knowledge of pure science provides the tools wherewith the applied lines of investigation are pursued, and while there are innumerable starting points, the channelling arising out of industrial considerations might not always be nearly so diverse. In some instances they are clearly not, as must occur, for example, with the work of the British Shipbuilding Research Association, the Parsons and Marine Engineering Turbine Research and Development Association, and the Ship Division of the N.P.L. The D.S.I.R. recognizes the importance of the accumulated resources of these three organizations being used to the full in the future technological development of the shipbuilding and allied industries, and aims to encourage flexibility in the respective research programmes.

The D.S.I.R. provides some of the finance of the research associations (the rest —most of it—is supplied by industry) and is concerned to see just how the money is spent. This should prevent overlapping and in a broad way make for efficient utilization of resources of all kinds. Detail is not so easily controlled, nor is it always desirable that it should be. Confirmation on parallel lines of work, for instance, can be valuable so long as it does not of itself become a pursuit. At the same time the wider implications of detail are not always apparent and often wait on chance contact. Early perception of the related importance of the different lines of work as they proceed is perhaps an ideal, but it offers such great possibilities that it also could well be a subject of research. The pace at which the research horizon widens is so rapid that some form of recording and indicating comparator is certainly needed to provide an overall perspective.

LOG SHEET

Orecrushing

The Indian Copper Corporation Limited has recently increased the output of its Masaboni Mine in Bihar State to about 100 ton per hr, necessitating the replacement of the existing crushing equipment which was unable to cope with the increased rate. The Corporation has therefore installed a Blake crusher fitted with extra-wide jaws (50 in. × 16 in.), the plant being manufactured at the Fraser and Chalmers Engineering Works of The General Electric Company Limited.

G.E.C. makes two sizes of Blake crushers with extra-wide jaws, namely 40 in. × 16 in. and 50 in. × 16 in. The particular value of these crushers is that they bridge the gap between the smaller range of jaw crushers and the larger true primary breaker. The two wide-jaw 16 in. crushers are specifically designed for reducing hard or tough ore which is not more than 12 in. in size to 3—4 in. ring at the rate of 50—100 ton per hr.

This feed rate cannot be handled economically in any single primary machine in the normal range. A 30 in. × 16 in. jaw crusher has too small a capacity, and the next larger size in the normal range, a 36 in. × 24 in. machine, is too big, since it is designed to take pieces considerably coarser than 12 in. and is therefore unnecessarily heavy and expensive for the smaller size of ore. A gyratory crusher with a 16 in. feed opening is much too large, its capacity being nearer 150 ton per hr.

One method of handling the tonnage would be to install two 30 in. × 16 in. crushers, involving duplication of the feed and discharge arrangements, the motor and the switchgear, this being very costly.

It will be seen therefore that crushers with extra-wide jaws satisfactorily cover the intermediate range of 50—100 ton per hr, being cheapest both in first cost and in running expenses. They have all the features of the improved design of Blake crushers, including all-welded construction throughout and roller bearings on the eccentric shaft for both the main frame and the pitman.

50 in. × 16 in. Blake crusher with extra-wide jaws

A Pound of Scandium

Production of a pound of scandium, an extremely rare metal, by Union Carbide International Company, New York, marks the first time that such a "large" quantity of scandium ever existed in one place at one time. The metal was produced for the Materials Laboratory, Air Research and Development Command and the Air Material Command of the United States Air Force at Wright Air Development Centre which required one pound (0·45 kg) of scandium of at least 99% purity. The material is in the form of two discs of scandium about 3⅛ in. (7·9 cm) dia and ¾ in. (19·1 mm) thick, the 99% purity of which met the United States Air Force contract specifications. The cost of completing this contract was shared partly by Union Carbide.

The United States Air Force is interested in scandium because it is believed to have some unique properties. It has a density comparable to aluminium, but at the same time has a relatively high melting point of 1550° C, or about two-and-one-half times the melting temperature of aluminum. The second contract, already under way, calls for an analysis of the material by Union Carbide to study its physical, chemical, and mechanical properties.

Machine Letter-sorting

The people of Norwich are the first in the world to use the new postal code, the beginning of a revolutionary step to open the way for the automatic sorting of letters. The codes for Norwich consist of six characters; three letters, two figures and one letter in that order, and follow the normal address on the envelope. The first three letters are NOR representing the name of the city, the two figures and final letter representing in most cases the name of a street.

The post office operators use a keyboard and depress keys corresponding to the characters of the code. These set up signals which are translated into one of 144 "instructions" telling the letter-conveying system of the sorting machine into which of 144 selection boxes it should put the particular letter.

The basic component of the postal code translator is the magnetic annulus with a strong hysteresis characteristic—the so-termed square-loop magnetic core. The particular core employed is formed by winding ¼ in. wide specially prepared nickel-iron alloy tape, 0·0015 in. thick, into the form of a 1 in. dia ring. This material, with a saturation flux density of 8000 gauss and a ratio of B rem./B sat. of approximately 0·8, provides the means of storing the sequence of electrical pulses generated by depressing the keys, and the means of recognizing any particular combination of stored signals.

Steel Prospects

According to the annual report of the British Iron and Steel Federation for 1959 the production of pig iron this year should reach a record level of about 16 million ton; crude steel production should reach, and may pass, 24 million ton, a figure some 20% higher than last year. The level of almost all finished products should increase considerably, with an especially substantial increase in steel sheet and if consumers build up stocks on anything like the scale of the 1955/57 period, then the industry may find itself hard put to meet all the demands made upon it.

The industry is at present engaged in estimating the demand for its products in the sixties, when it is likely that in the home market the consumers whose steel requirements should be expected to grow at a particularly fast rate are the motor and general engineering industries, especially those making consumer durable goods. The steel requirements of the coal mining and railway industries are expected to fall and the shipbuilding industry's requirements to rise comparatively little. In overseas markets the prospects for a growth in exports are expected to be favourable.

Companies have been asked to give the Federation an indication of their future intentions as to modernization and expansion. It looks as if the emphasis in the next phase of development will shift away from rapid overall expansion to ensure that the pattern of finished steel

production is adapted to the rapid changes taking place in the economy and that the industry will be even more closely concerned with efficiency of production and its costs. In steelmaking in particular it looks as if the sixties will see a drastic change in the pattern of production with a marked growth of output from the new pneumatic processes and electric furnaces and with the use of oxygen as one of the primary steelmaking raw materials.

Mr. Richard Summers, the president of the Federation, says in the foreword to the report: "Technical developments now under way should be able to bring stability or even a reduction in the cost of British steel over the next decade if the community at large is able to conduct its affairs with sufficient restraint to avoid a constantly rising general level of prices. The year ahead offers a high level of activity in the industry and the prospect of a record level of steel output".

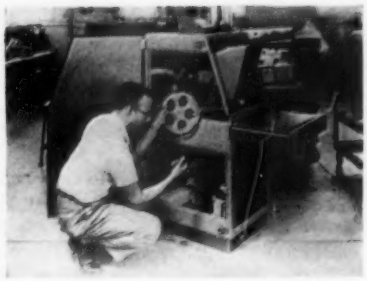
Teaching Machine

An automatic teaching machine which can instruct anyone on virtually any subject, ranging from bridge or golf to complex electronic problems or abstruse mathematical formulae was introduced recently. Named the Auto-Tutor, the machine has been developed in the United States by U.S. Industries Inc. It is claimed to be the first machine to achieve the teaching function through integrated student participation. It is expected that initially its most useful role will be in large industrial and military training programmes. It is anticipated that the machine will be manufactured in the United Kingdom.

The Auto-Tutor presents questions on any chosen subject to the student. If he answers correctly, the machine congratulates him and sets a further task. If the student is wrong, the machine tells him how and why and encourages him to tackle the problem again, after giving him further information. The Auto-Tutor can assess real knowledge and rate of progress so that the true educational level of the student is revealed.

Advantages are that, treating the student as an intelligent human being, the tutor advances him at a rate determined by his own ability, frees the teacher for creative work, records progress of the trainee and provides a record of the individual's approach and reasoning process.

The student controls it by pressing combinations of buttons, which total



Above and right, Auto-Tutor automatic teaching machine

40, according to which answer he chooses. Each alternative answer shows a new image number alongside it. The tutor automatically locates and presents the new image. Thus the microfilm may be ordered to go forward or backward to any one of 9,999 numbers corresponding to images on the microfilm. If the answer is incorrect the tutor tells the student so, explains why, supplies him with additional material to correct his error, and instructs him to return to the first image and try again.

If, on the other hand, the student selects the right answer, the device congratulates him, supplies him with the next unit of information and the next multiple-choice question. Thus the machine develops knowledge of the subject matter step-by-step at any student's own pace, making sure at each step that the point has been grasped completely and developing in a logical manner the student's knowledge, based on what he has already learned.

Thanks to the combination of still and motion picture capabilities, the machine can instruct not only by photographed printed material, but by means of actual demonstrations in motion, teaching industrial techniques, experimental methods, chemistry, physics or any other subject.

The machine prints on paper tape a complete record of each student's progress. The tape contains a step-by-step history of the sequence of images used by the student and the time he spends dealing with each image.

The automatic tutoring method was devised by Mr. Norman A. Crowder, a research psychologist who is manager of the training system department of the Western Design Division on U.S. Industries in the United States. It is expected that the tutor will cost in the region of between £1,000 and £4,000.

Continuous Casting Plant

The new four-strand continuous casting plant which Distington Engineering Company Limited, are to build and instal at Appleby-Frodingham Steel Company, Scunthorpe, will have the largest productive capacity in the world for a machine of its type.

Equipped to cast four strands of 9-in. square blooms it will operate from 100-ton ladles of steel with a weekly production capacity of 5,000 tons. It is scheduled to begin operations in December, 1961.

Liquid steel will be poured from the ladle into a common tundish, with four stopper-controlled nozzles feeding direct into the copper moulds. After leaving the spray cooling chamber, the solidified blooms—withdrawn through pairs of withdrawal rolls—will be cut off vertically into 30 ft lengths. These will be discharged at ground level by means of a discharge conveyor mechanism. The blooms will then be transferred to a new 32 in. reversing mill for rolling into billets to feed the new Appleby-Frodingham rod/bar mill, which will have a capacity of 300,000 tons per annum of finished products.

Inch-metric Problems

In a paper read at the 1960 conference of standards engineers, Mr. T. R. B. Sanders, engineering advisor to the British Standards Institution, referred to the recently-published report on decimal coinage and the metric system prepared by committees of the British Association and the Association of British Chambers of Commerce. "Decimal thinking" was recommended, and he was glad of this move towards decimals. Where, for example, could one get a micrometer reading in $\frac{1}{32}$ or $8\frac{1}{4}$?

Mr. Sanders went on to speak of the importance of finding solutions to the difficulties of international standardization where linear dimensions were involved. "The

problem of dimensional standards has been shown to be one of the most crucial, and we perhaps stand to gain more than any other country from successful efforts to secure a greater alignment between inch and metric sizes," he said.

In furtherance of this objective, a working group in ISO (International Standards Organization) had framed tables of "corresponding sizes". These tables were intended to indicate what could be done, rather than just how it should be done. In them a series of sizes were put forward which would involve the least possible change from existing practices in both inch and metric countries. Alongside these were tabulated the appropriate preferred series (the R20 series was found in the main to be most appropriate) so that at a later date, as new designs were brought in, the movement could be towards greater conformity with the exact preferred numbers. Certain sizes representing wide current practice in one system only called for a concession from countries using the other system; for example, metric countries were asked to adopt 12·5 millimetres instead of 12·0 millimetres and inch countries were asked to adopt 0·8 inch instead of 0·75 inch.

Storekeeping by Computer

In the four years since the Ford Motor Company's £2 million parts depot at Aveley in Essex, built under the company's recently completed £75 million expansion programme, came into operation, the number of different parts stocked has increased from 35,000 to 46,000. In the same period, the daily tonnage of material shipped to all parts of the world has increased from 100 to 160 ton.

To speed the processing of orders through the depot a LEO Mark II electronic computer was installed. During recent months it has been used progressively in the preparation of customer despatch and invoice documents covering demands for over 5 million order items per annum. In addition, it records all these customer demands and produces sales statistics to assist in establishing future requirements of parts. The computer also provides a stock control system which checks availability of items before preparing despatch documents, aggregates the stock movements and provides each morning an up-to-date record of the stock of each of the 46,000 parts.

Fords also use a Leo computer for handling the pay-roll of up to 30,000 of its employees weekly, and delivery is expected this year of another Leo of the latest type to handle the company's production and assembly programme.

Automatic Boiler Control

Since the introduction of the Kelvin Hughes system of automatic boiler control at Strathclyde Hospital, Scotland, an overall increase in the boiler efficiency of 6·3% has been achieved and steam production costs reduced, in spite of a considerable increase in steam demand. With

POLY-V DRIVE.—This Poly-V drive is in the engine house of Smith & Grace Limited, Kettering, where a 140 hp engine running at 500 rpm drives a 90 kW alternator at 1000 rpm. The Poly-V belt is 9 in. wide and replaces 10 D-section V-belts. The drive has been running for 3½ year maintenance-free and without trouble. Poly-V belt is made by Turner Brothers Asbestos Company Limited, Rochdale.

the manual system of control, the ratio of steam generated per pound of coal averaged 8·47 lb with the boilers operating at an average efficiency of 70·4%. On automatic control the average has been raised to 9·29 lb and the efficiency raised to 76·7%. At Strathclyde the greatest demand is made by the hospital laundry and here the new system has ensured an efficient calendaring cycle and achieved a reduction of 4% in the cost of steam per pound of clothing laundered.

The boilerhouse installation consists of two Ruston & Hornsby "Thermax" super economic boilers rated at 6000 lb/hr from and at 212° F at a working pressure of 100 psi, fitted with Bennis chain grate stokers. Forced and induced draught is employed. Water feed is by two Wier pumps of 8000 lb/hr capacity each, automatically controlled by Ronald Trist boiler water level controls.

The instrumentation consists of one panel containing draught gauges, circular chart recorders recording flow and pressure, CO_2 indicators, temperature indicators and strip chart recorders recording CO_2 and temperature. The control equipment comprises a master steam pressure controller, two combustion controllers and two stoker speed controllers.

Plastics Equipment

The Bureau voor Bedrijfsdocumentatie (Economic Documentation Office) of Hilversum, Holland plans to publish a reference work entitled "Equipment for the Plastics Industry" based on the product classification system, giving the names and addresses of European manufacturers of plants, machines, equipment and accessories for the plastics industry. There will be no charge for the publication of these data. Since this volume will be distributed on an international scale, it will contain English, French, German, Spanish and Italian indexes. Manufacturers who wish to have their company included in this publication are requested to apply for a form to the above-mentioned bureau. The address is: 30A, Graaf Florislaan, Hilversum, Holland.

Cold Plate Bending

A 3-roll cold plate bending machine capable of bending mild steel plate up to 4¾ in. thick has been installed at the Erith engineering works of The General Electric Company Limited. This is believed to be the largest machine of its type in this country and its installation places the company in a position to bend the thickest plate likely to be encountered in pressure-vessel work. The bending machine has already been used to roll sections of the shells of winding engines and for work in connexion with machines for Hunterston nuclear generating station. Supplied by Wagner and Company, Dortmund, Germany through their British agents, Vaughan Associates Limited, the machine weighs 126 ton and has approximate overall dimensions of 42 ft by 13¾ ft by 17½ ft high. The total cost, including import duty but excluding installation charges was approximately £82,000.

The rolls can be used for two purposes namely pre-bending and bending. They pre-bend steel plates

(32 ton per sq in. tensile) 13 ft 1¼ in. wide by $2\frac{3}{32}$ in. thick or 6 ft $6\frac{3}{4}$ in. wide by 3 in. thick; the corresponding thicknesses for bending are $3\frac{5}{32}$ in. and $4\frac{3}{4}$ in. The minimum plate thickness which can be rolled is $\frac{3}{8}$ in., the minimum diameter depending on plate thickness and width. Certain plate sizes can be bent to the diameter of the top roll, namely 2 ft 7½ in. Bending speeds are 16·4 fpm and 9·8 fpm depending on the plate dimensions.

The bottom rolls are vertically adjustable individually, and as a combined unit, and this enables the new machine to roll the plates, and pre-bend them at both ends without having to turn the plates. It therefore incorporates the advantages of the normal 3-roll plate bending machine with those of the 4-roll machine. The two main motors are of the wound rotor type, the pre-bending unit being rated at 107 hp (for vertical adjustment of the bottom rolls), and for the bending operation, 167 hp.

Orbiting Power Station

John W. Simpson, vice president in charge of the Westinghouse Electric Corporation's atomic division, recently told scientists and engineers attending the 1960 American Nuclear Congress that in ten year's time the United States will be able to put into orbit a nuclear-powered generating system with a capacity of 60,000 kW—enough power to supply the residential needs of a city of 120,000 people.

This prediction is based on the belief that by 1970 a kilowatt of power will be obtained from every four pounds of payload and therefore 120 ton of payload will give the 60,000 kW output needed. To put such a weight into orbit will require powerful boosters but, according to Mr. Simpson, such boosters are being planned and, with the development of nuclear rockets, far heavier payloads will be possible.

Mr. Simpson also spoke on the problems of space propulsion and the merits of the nuclear and chemical propulsion systems. In applications such as intercontinental ballistic missiles and close-in satellites he pointed out that existing chemical rockets performed so well that it would be of limited value to develop atomic power as an alternative system. It is in the long range and big missions that nuclear rockets will probably first show their advantage. He thought the zenith of the nuclear engine was so far out that it was difficult to make a prediction as to when it would be reached. It would supplant the chemical system only when it could be made as safe, reliable and practical as ship and utility reactors today.

Billet and Wire Scheme

Samuel Fox and Company Limited, a subsidiary of The United Steel Companies Limited, are to spend over £4½ million on a development scheme to expand ingot steel production from 400,000 to 500,000 ton per annum. The main expenditure will be on increased rolling mill capacity to convert ingots into billets and slabs and for improved handling and finishing of the resultant products.

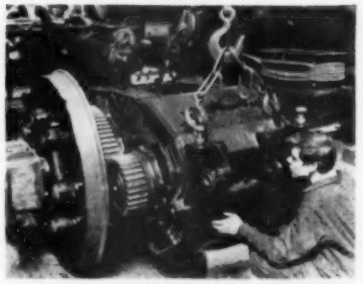
Following the installation of a modern blooming mill in 1955, the billet mill at the Stocksbridge works was reconstructed in 1958, when two 32 in. two-high reversing finishing mills with independent electric drives were installed. It is now planned to introduce an electrically driven two-high intermediate mill, which will replace an old two-stand steam driven mill, and to add a small retractable stand for rolling rounds.

To provide additional space for the finishing processes on billets and slabs, the existing billet mill building is to be extended and a new building is to be erected at the eastern end of the works which will be used for these and other operations.

As the billet mill extensions will over-run the existing site of the wire department the latter is to be removed to the west end of the works. The scheme as a whole is expected to create greater opportunities for employment, ultimately involving some 400 more men.

Standards Engineers

A firm decision was taken by delegates attending the 1960 conference of standards engineers to bring together in an association all those concerned with the application of standards in industry. It was agreed that no separate organization —as was earlier envisaged—should be set up but that standards engineers and others with a special interest would be able to become associates, on a personal basis, of the British Standards Institution. The new proposals were outlined to delegates by the director of B.S.I., Mr. H. A. R. Binney. He explained that the new associates scheme would provide



TRACTION MOTOR.—This AEI 847 hp traction motor is seen being fitted to an a.c. locomotive wheel and axle set at the Gorton Works of Beyer Peacock Limited, where 10 of 35 AEI 3300 hp a.c. locomotives for British Railways are being built. The motor is of the normal d.c. type with inductive resistances having been fitted across the field coils to enable it to operate satisfactorily with the a.c. ripple. Thus the a.c. components are by-passed from the motor fields, while connecting the poles by a laminated ring inside the yoke casting keeps interpole flux and armature current in phase. There are four motors on each locomotive permanently connected in parallel. They are fully spring borne the drive being transmitted to the road wheels by Alsthom type quill drive

"standards practitioners" with the forum they so evidently desired, and in which they could meet, hold discussions and exchange views.

It was agreed that associates would be organized on a regional basis to allow for convenience of meetings and that initially a fee of a guinea a year would be charged for B.S.I. services. Standards engineers wishing to participate in the associates scheme are invited to write to the Joint Secretary, I.Prod.E./B.S.I. Committee, British Standards House, 2, Park Street, London W1.

World Power Conference

Australia has been chosen by the International Executive Council of the World Power Conference as the host country for the sixth plenary meeting of the World Power Conference which will be held in Melbourne from October 20 to 26, 1962. The subject of the plenary meeting will be "The Changing Pattern of Power", and the technical programme will provide for this subject being dealt with in five major divisions: energy resources, based on the World Power Conference survey of energy resources and surveys prepared by national committees; the production and amelioration of primary sources of energy; transformation of primary to secondary energy, and transportation of energy; utilization of primary and secondary energy; economic evaluation of alternative energy sources.

With the publishing of the technical programme initial action for the submission of a total of 200 papers by January, 1962, from 59 member nations of the World Power Conference will be inaugurated.

Damped Vibrations

By W. H. SHEPPARD, B.Sc.(Eng.)

IN considering the vibration of bodies in viscous media such as air or oil, it is usually indicated in recognized works that the displacement—time curve is sinusoidal—exponential with an exponential envelope, but paradoxically this envelope appears to be that which geometrically would pass through the crests, which is impossible. Also, it is often stated that in the case of critical damping the curve is approximately exponential which, when considering the application of a damping medium to a vibrating member, is also impossible. Actually this is the most important case but it is usually dealt with in a very sketchy manner. To explain these apparent anomalies an investigation was carried out and the results are given below.

To introduce the subject, free vibration and free damping are first considered independently and then the combined effect explained. The word "free" is used to indicate that there is no external force applied. To simplify the exposition, mathematical principles used are described first in each section.

I. Free vibration

Geometry. Consider the graph of the function $y = A \sin bx + B \cos bx$. This has the form shown in Fig. 1 and is referred to as sinusoidal. It may be regarded as generated by a rotating vector shown to the left.

An alternative form of the equation is obtained by taking

$$y = r(\cos bx \cos\phi + \sin bx \sin\phi)$$

whence $y = r \cos(bx - \phi)$

where $A = r \sin\phi$ and $B = r \cos\phi$

or $\tan\phi = B/A$ and $r = \sqrt{A^2 + B^2}$

alternatively

$$y = r \sin(bx + \phi)$$

where $A = r \cos\phi$ and $B = r \sin\phi$

or $\tan\phi = A/B$ and $r = \sqrt{A^2 + B^2}$

Usually general cases may be simplified by shifting the x axis by angle ϕ.

If $B = O$, $y = r \sin bx$. This is the simplest case since the graph starts at the origin but unfortunately is not always realized in practice. If $A = O$, $y = r \cos bx$. This is the more practical case.

To obtain the exponential form

$$y = A\left(\frac{\epsilon^{jbx} + \epsilon^{-jbx}}{2}\right) + B\left(\frac{\epsilon^{jbx} + \epsilon^{-jbx}}{2}\right)$$

$$\therefore\ y = A'\epsilon^{jbx} + B'\epsilon^{-jbx}$$

where $A' = \frac{1}{2}(A + B)$ and $B' = \frac{1}{2}(A - B)$

or $A = A' + B'$ and $B = A' - B'$

The radius of curvature (R) is useful for tracing curves and is given by $R = [1 + (dy/dx)^2]^{3/2}/d^2y/dx^2$ which for the sinusoidal case is $-(b/y)[r^2 - y^2 + 1/b^2]^{3/2}$

At the crests $R = 1/ab^2$. If $b = 1$, $R = a$.

If X is the horizontal distance between corresponding points, $X = 2\pi/b$ or $b = 2\pi/x$.

Calculus.—Consider the equation $d^2y/dx^2 + k^2y = O$

The solution is given by

$$y = A \sin bx + B \cos bx$$

$$dy/dx = b(A \cos bx - B \sin bx)$$

$$d^2y/dx^2 = -b^2(A \sin bx + B \cos bx) = -b^2y.$$

It will be realized that the differential equation is satisfied by any real value of b, but exponential forms of the solution are imaginary.

Simple harmonic motion.—This will be defined as the motion of a point at the foot of a perpendicular to the diameter of a circle, from a point moving with constant speed along the circumference. It is shown in works on mechanics that the following alternative definition may be deduced:

(1) A point moving in a straight line under the conditions $\underline{S} = A \sin k\underline{t} + B \cos k\underline{t}$ or the alternative forms of the equation, using $\underline{s}$ and $\underline{t}$ for x and y respectively.

(2) A point moving such that the acceleration is proportional to its displacement from a fixed point and directed thereto. It follows that if the point refers to a constant mass, the applied force varies as the distance from the origin.

(3) A point moving such that $d^2s/dt^2 + k^2 S = O$. With regard to the constant k, it may seem like an artifice to keep it positive, but actually k is equal to ω, the angular velocity of the rotating vector. If the sign in the equation is negative or k imaginary, the motion becomes hyperbolic, such as that of a heavy chain rolling over a pulley.

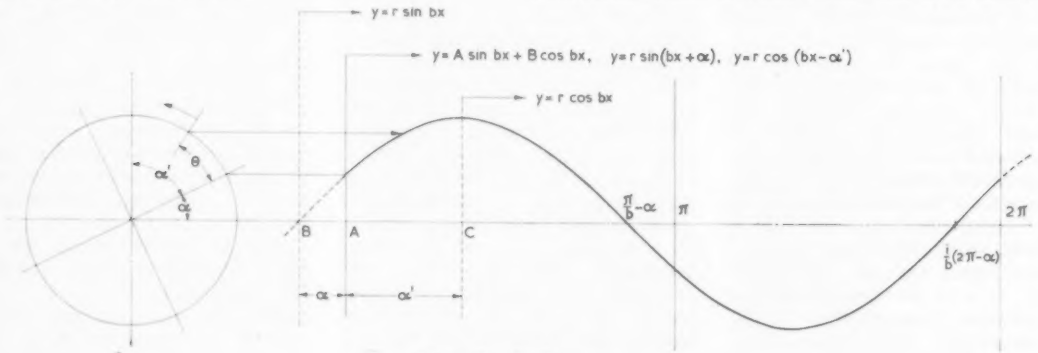


Fig. 1.—Free vibration curves

In general, the converses are true, i.e. points which move under any of these conditions execute single harmonic motion.

Alternative forms of the equation are

$$S = r \sin(\omega t + \phi)$$
$$S = r \cos(\omega t - \phi)$$

and special forms are

$$S = r \sin \omega t$$
$$S = r \cos \omega t$$

Considering the first form,

velocity $v = ds/dt = r\omega \cos \omega t = r\omega \sqrt{1 - s^2}$

acceleration $f = dr/dt$ or $d^2s/dt^2 = -r\omega^2 \sin \omega t = -\omega^2 s$

and similarly for the other forms of the equation for s. In all cases θ, the angular displacement of the vector may be substituted for ωt.

Vibration.—Now consider a mass moving under the action of a force proportional to the displacement and tending to return it ot its original position. The simplest case is a mass m attached to an elastic medium of stiffness s.

At any instant $P = mf$

P = force, m = mass, f = acceleration.

$$Sy = -md^2s/dt^2$$
$$d^2s/dt^2 + (S/m)y = O$$

S/m is equal to the vibration modulus (σ) (μ is usually used but is avoided here to prevent confusion with friction and in any case should not be confused with other moduli).

Thence $d^2s/dt^2 + \sigma y = o$

Since this compares with the equation

$$d^2y/dt^2 + k^2y = o$$

the motion is single harmonic and $k = \sqrt{\sigma}$ or $\sqrt{S/m}$.

$$\therefore \quad S = A \sin \sqrt{\sigma}t + B \cos \sqrt{\sigma}t$$

If $s = o$ when $t = o$, $S = A \sin \sqrt{\sigma}t$, the simplest case.

If $ds/dt = o$ when $t = o$ $s = A \cos \sqrt{\sigma}t$ . . This is the more practical case corresponding to the release of a member for free vibration from a deflected position. Alternative trigonometric and exponential forms are applicable.

Angular velocity of vector $\omega = \sqrt{\sigma}$. Frequency $N = \omega/2\pi = \sqrt{\sigma}/2\pi$ = Period $T = 1/N = 2\pi/\sqrt{\sigma}$.

Length of equivalent single pendulum $L = g/\sigma$ ($T = 2\pi \sqrt{L/g}$).

II. Free Damping

Geometry.—Consider the graph of the function $y = Ae^{-Bx}$. This has the form shown dotted in Fig. 2. in which A and B are taken as 1. The important property of this exponential curve is that the slope is proportional to the vertical ordinate. The negative portion is being considered here as applicable to the subject but the positive portion has similar properties.

Calculus.—Consider the equation $dy/dx + ay = o$. The solution is given by $y = Ae^{-ax}$

$$dy/dx = -Abe^{-ax} = -ay$$

and the function is therefore exponential. (In the case where the constant is negative, $y = e^{ax}$).

Damped motion.—Consider a massless body immersed in a viscous medium under the action of an elastic member of stiffness S. Let the resistance due to the viscous material be R and proportional to the velocity v, the constant being ν being the "thinness" or reciprocal viscosity.

Then $R = P$

$$\nu\, ds/dt = -S_s$$
$$ds/dt + S_s/\nu = o$$

This agrees with the equation

$$y = Ae^{-kx}$$

$\therefore$ the motion is exponential $S = re^{-(s/\nu)t}$

which type of motion is referred to as "decay" (or when inverted as "growth". Pure exponential motion is only possible with zero mass, though it may be closely approximated if the mass is negligible. Under this condition (i.e. zero mass) any virtual viscocity will give a periodic motion.

The time which would be taken for complete decay at *the original rate of decrease* is the *time constant* T. If $y = Ae^{-at}$, $T = 1/a$ and in the above case $T = \nu/S$. The ordinate of T is equal to $1/e = 0{\cdot}3679$ expressed as a ratio of A. (In growth function the value is $1 - 0{\cdot}3679 = 0{\cdot}6321$.) The value is usually considered negligible after $5T$ but $3\pi/2$ ($= 4{\cdot}7124$) gives practically the same result and is more fundamental.

III. Free damped vibrations

Geometry.—Consider the graph of the function $y = e^{-ax}(A \sin bx + B \cos bx)$. This has the form shown in Fig. 3, being a wave motion of decreasing amplitude referred to as sinusoidal—exponential and may be regarded as a sinusoidal curve compressed between the pair of exponentials $y = \pm e^{-ax}$. Here it should be particularly noticed that the points of tangency are midway between the intersections on the x axis whereas the crests are each displaced therefrom by an equal amount. Thus the lobes of the curve are "lop-sided". Unfortunately they are often drawn sinusoidally giving the apparent anomaly of the tangents being offset yet agreeing with the exponentials through the crests and are sometimes explained by approximation. It should be realized, however, that the crests also conform to exponential curves shown dotted. Alternative exponential forms of the equation are

$$y = A^1e^{-ax+jbx} + B^1e^{-ax-jbx}$$

where $A^1 = \frac{1}{2}(A + B)$ and $B^1 = \frac{1}{2}(B - A)$

or $A = A^1 - B^1$ and $B = A^1 + B^1$

Special cases also apply, $y = Ae^{-ax} \sin bx$ and $y = Ae^{-ax} \cos bx$

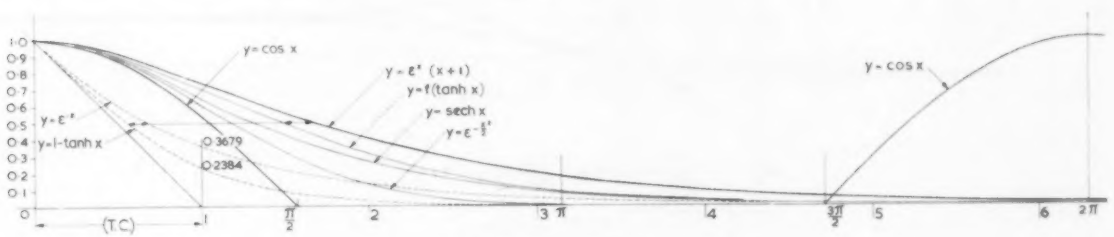


Fig. 2.—Free damping curves

Next consider the graph of the function $y = \epsilon^{-ax}(A \sinh bx + B \cosh bx)$. This may give a variety of curves increasing to infinity or decreasing asymptotically to zero according to the relative values of A and B.

Also consider the graph of the function $y = \epsilon^{-ax}(Ax + B)$. This has the form produced by the product of the ordinates of the exponential curve and a straight line.

Calculus.—Consider the equation $d^2y/dx^2 + \alpha dy/dx + \beta y = o$

This has three solutions depending on the relative values of α and β

I. $\beta > (\alpha/2)^2$

$$y = \epsilon^{-ax}(A \sin bx + B \cos bx)$$
$$d^2y/dx^2 = b\epsilon^{-ax}(A \cos bx - B \sin bx)$$
$$dy/dx^2 = -b^2\epsilon^{-ax}(A \sin bx + B \cos bx)^2 - b^2y$$

where $a = \alpha/2$ and $b = \sqrt{\beta - (\alpha/2)^2}$

II. $\beta < (\alpha/2)^2$

$$y^2 = \epsilon^{-ax}(A \sinh bx + B \cosh bx)$$
$$dy/dx = b\epsilon^{-ax}(A \cosh bx + B \sinh bx)$$
$$d^2/dx^2 = b^2\epsilon^{-ax}(A \sinh bx + B \cosh bx) = b^2y$$

where $a = \alpha/2$ and $b = \sqrt{(\alpha/2)^2 - \beta}$

III. $\beta = (\alpha/2)^2$

$$y = \epsilon^{-ax}(Ax + B)$$
$$dy/dx = \epsilon^{-ax}(A - aAx - aB)$$
$$d^2y/dx^2 = \epsilon^{-ax}(a^2Ax - 2aA + a^2B)$$

where $a = \alpha/2 = \sqrt{\beta}$.

These results may each be checked by substitution. The differential equation is often written $d^2y/dx^2 + 2a.dy/dx + (a^2 + b^2) = o$. Exponential forms, alternative forms and special cases also apply.

Free damped vibrations.—This will be taken to include over damped and critically damped motion in addition to actual vibratory motion. Consider a mass moving under the action of a force proportional to the displacement and also in a medium of virtual viscosity v.

At any instant $P = mf$.

$$Sy + v.\ ds/dt = -m\ d^2s/dt^2$$
$$d^2s/dt^2 + v/m\ \ ds/dt + s/m = o$$

This is comparable with the equation

$$d^2y/dx^2 + \alpha dy/dx + \beta y = o$$

with $\alpha = 0/m$ and $\beta = s/m$ whence $a = v/2m$ and $b = \sqrt{s/m \sim (v/2m)^2}$

I. If $S > v^2/m$

$$S = \epsilon^{-at}(A \sin bt + B \cos bt)$$

This is the sinusoidal-exponential function with exponential envelopes and crest points. As explained previously, the tangent points and *not* the crest points are at intermediate ordinates. Fig. 2 shows an example where $a = 1$ and $b = 2\pi$ in lieu of 1 as the latter gives such a protracted curve. Special cases will now be considered.

(a) $\underline{S} = r\epsilon^{-a\underline{t}} \sin b\underline{t}$ when $x = o$, $y = o$

This is the simplest case but rarely realized in practice. In general cases however it is often convenient to shift the $\underline{y}$ axis to conform to this case.

(b) $\underline{S} = r\epsilon^{-a\underline{t}} \cos b\underline{t}$

In this case the curve and envelope both start at the $\underline{y}$ axis with the same ordinate and slope. This is rarely realized in practice but often confused with the following.

(c) $\underline{S} = r\epsilon^{-a\underline{t}}[\cos b\underline{t} + (a/b) \sin b\underline{t}]$

In this case $ds/dt = o$ when $t = o$ representing the most important case of a body released from a deflected position to undergo free vibration in a viscous medium.

II. $S < v^2/m$

$$\underline{S} = r\epsilon^{-a\underline{t}}(A \sinh b\underline{t} + B \cosh b\underline{t})$$

This is the general case of non-vibrating motion due to over-damping. In the special case

$$\underline{S} = r\epsilon^{-a\underline{t}}[\cosh b\underline{t} + (a/b) \sinh b\underline{t}]$$

$ds/dt = o$ when $t = o$ corresponding to free release from a deflected position. If $S = o$, $y = r\epsilon^{-v/m}(\sinh v/m + \cosh v/m) = r$ corresponding to infinite damping and no movement.

III. In both the previous cases if $S = v^2/m$ the results for y are indeterminate but the following solution is applicable.

$$\underline{S} = r\epsilon^{-a\underline{t}}(A\underline{t} + 1)$$

This is critical damping representing the quickest return to origin, and in general is the most important case. If $s = r$ and $ds/dt = o$ when $x = o$

$$\underline{S} = r\epsilon^{-a\underline{t}}(a\underline{t} + 1)$$

This graph, corresponding to free release, changing gradually from sinusoidal to exponential as shown in Fig. 2. The term "Time Constant" may be retained in this case to imply the same meaning as damping without

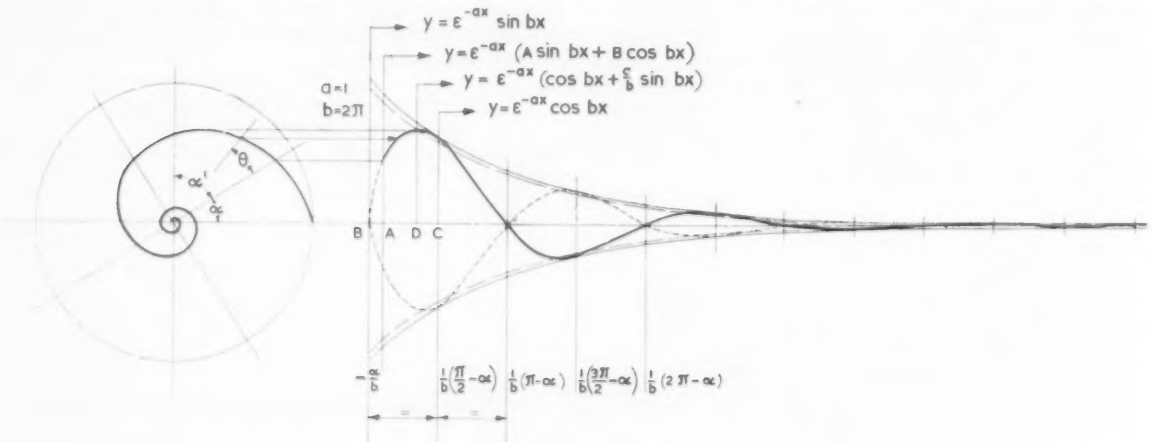


Fig. 3.—Free damped vibrations

inertia but reference to the graphs will show that although the ordinate is small at $5T$ or $(3\pi/2)\,T$, it becomes negligble at $6T$ or $2\pi.T$. This case may also be considered as a single pendulum of length $g/\sqrt{\sigma}$, but with a vane attached to give damping, the three cases applying.

Logarithmic decrement. (δ).—This is the ratio of displacements in corresponding points in successive cycles (if negative lobes are reversed, care must be taken to take alternate points). This is identical for any pair of corresponding points. It is usually taken as crest points but might equally well be taken as intermediate points. It is sometimes mis-stated that these are approximate. It may be shown that in the above cases $\delta = -2\pi\, a/b$.

If $a = 1$ and $b = 2\pi$, $\delta = -1$, decrement $\Delta = 0{\cdot}3679$. Corresponding points are in geometric progression, the *C.R.* being Δ or antilog δ.

Curve tracing

Any of the curves may be plotted by taking corresponding values of x and y or alternatively plotting graphs of individual parts and taking the products. The latter is very instructive in the principles involved. An alternative method for vibratory motion is to plot the equiangular spiral $r = \epsilon^{-a\theta}$ as shown at the left of Fig. 3 and project equally spaced points. It should be noted that the intersections of the curve with the x axis are not necessarily points of inflexion. Actually if $a = b$ the points of tangency are also points of inflexion. The slopes of the curve at the x axis are also in exponential series. Radii of curvature are useful for plotting. In most cases it is usually preferable to shift the x axis to conform to $y = r\epsilon^{-ax}\, sin\, bx$, the angle of shift being given by δ in the following table:

$$y = r\epsilon^{-ax}\,(A\, sin\, bx + B\, cos\, bx)$$
$$y = r\epsilon^{-ax}\, sin\,(bx+\delta)$$
$$\delta = tan^{-1}\,(B/A),\ r = \sqrt{A^2+B^2}$$
$$y = r\epsilon^{-ax}\, cos\, bx$$
$$y = r\, sin\,(bx+\delta)$$
$$\delta = \pi/2$$
$$y = r\epsilon^{-ax}\,(cos\, bx + a/b\, sin\, bx)$$
$$y = r^1\epsilon^{-ax}\, sin\,(bx+\delta)$$
$$\delta = tan^{-1}\, a/b\ r^1 = \sqrt{(a^2+b^2)/b}$$

Salient points will now be given for the simple case $y = r\epsilon^{-ax}\, sin\, bx$

$$dy/dx = r\epsilon^{-ax}\,(b\, cos\, bx - a\, sin\, bx)$$
$$d^2y/dx^2 = r\epsilon^{-ax}\,[(a^2-b^2)\, sin\, bx - 2\, ab\, cos\, bx]$$
$$d^3y/dx^3 = r\epsilon^{-ax}\,[a(3b^2-a^2)\, sin\, bx + b(3a^2-b^2)\, cos\, bx]$$

$y = o \quad x = o,\ \pi/b,\ 2\pi/b,\ 3\pi/b\ \ldots$
$dy/dx = \pm\, rb\epsilon^{-ax} = y$
$R = -(1+y^2)^{3/2}/2ay$

Intermediates $x = \pi/2b,\ 3\pi/2b,\ 5\pi/2b\ \ldots$
$y = \pm\, r\epsilon^{-ax} = y;$
$dy/dx = \mp\, ay$
$R = [1+(ay)^2]^{3/2}/(a^2-b^2)y$
(If $a = b$, $R = \infty$)

Crests $dy/dx = o$
$x = (-\phi/b),\ (1/b)\,(\pi-\phi),\ (1/b)\,(2\pi-\phi)\ldots$
$\phi = tan^{-1}\, b/a.$
$y = (b/\sqrt{a^2+b^2}) \times y_i$
$R = -1/(a^2+b^2)y$

Inflexions $d^2y/dx^2 = o$
$x = (-\phi'/b),\ 1/b\,(\pi-\phi'),\ 1/b\,(2\pi-\phi')\ldots$
$\phi' = tan^{-1}\, 2ab/(a^2-b^2)$
$y = [2ab/(a^2+b^2)] \times y_i$
$dy/dx = \mp\, by_i$

Maximum Curvature
$d^3y/dx^3 = o$
$x = \delta''/b,\ (1/b)\,(\pi-\phi''),\ (1/b),\ (2\pi-\phi'')\ \ldots.$
$\phi'' = tan^{-1}\,[b(3a^2-b^2)/a(3b^2-a^2)]$
$y = b(3a^2-b^2)/(a^2+b^2)^{3/2}\, y_i$
$dy/dx = +ab(b^2-a^2)/(a^2+b^2)^{3/2}\, y_i = \dot{y}$
$d^2y/dx^2 = b(5a^4-10a^2b^2+b^4)\, y_i = \ddot{y}$
$R = (1+\dot{y}^2)^{3/2}/\ddot{y}$

$y = o$
$y = r\epsilon^{-ax}\,(cos\, bx + a/b\, sin\, bx)$
$x = (1/b)\,(\pi-\phi),\ (1/b)\,(2\pi-\phi),\ (1/b)\,(3\pi-\phi)\ldots$
$\phi = tan^{-1}\, b/a$
$dy/dx = -r\sqrt{a^2+b^2}\,\epsilon^{-ax} = y'$
$R = \infty$ giving points if inflexion.

Intermediates $x = \pi/2b,\ 3\pi/2b,\ 5\pi/2b\ \ldots$
$y = r\, a/b.\ \epsilon^{-ax}$
$dy/dx = \mp\, r(a^2+b^2)b.\ \epsilon^{-ax} = y'$
$R = (1+\dot{y}^2)^{3/2}/a\ddot{y}$

Crests $x = o,\ \pi/b,\ 2\pi/b,\ 3\pi/b\ \ldots$
$y = \pm r\epsilon^{-ax} = y_c$
$R = 1/a(a^2+b^2)y$

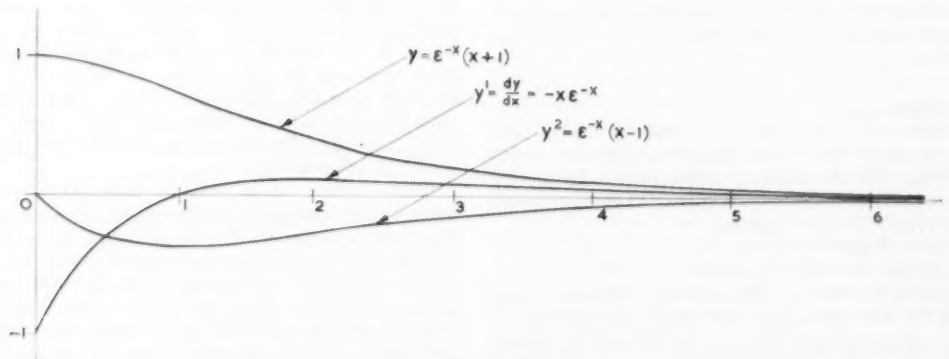


Fig. 4.—Critical damping curves

Maximum Curvature

$$x = \phi'/b,\ 1/b\,(\pi-\phi'),\ 1/b(2\pi-\phi')$$
$$\phi' = tan^{-1}\ 2ab/a^2-b^2)$$
$$y = 3a^2-b^2/a^2+b^2\ y_c.$$
$$dy/dx = 2ay_c$$
$$R = 1+(2ary_c)^2/ra(a^2+b^2)$$

With regard to non-vibrating motion, curves are easily plotted by taking co-ordinate points. As regards critical damping from free release, the graph changes gradually from sinusoidal to exponential.

Velocity.—Curves may be plotted by differentiation and acceleration curves by second differentiation, either by the formulae given or by drawing a series of tangents. Vibratory motion gives similar curves in different phases. Critical damping for velocity gives a curve rising fairly sharply and falling gradually and for acceleration a curve dipping below axis at first, rising above and falling gradually. (See Fig. 4.)

Square law

In the previous calculation, viscous resistance has been assumed proportional to the velocity but in practice this may be proportional to the square of the velocity or an intermediate value. This implies that the velocity must *decrease* quicker, agreeing with the differential equation. Unfortunately there is no solution to this equation. The graph of $y = \text{shec}\ x$ gives a good slope as does the decay function $y = \epsilon^{-x^2/2}$, both of these being shown in Fig. 2. Approximations to these functions might be obtained in an instrument by a vane dipping in oil to give greater damping at the zero position, but this would only apply to a centre-reading or "nul" type. A good result for the square law might be obtained by analogy as follows, however:—If a body falls freely under gravity with resistance proportioned to the velocity, the latter is proportional to $1-\epsilon^{-kt}$, whereas if the resistance is proportional to v^2 the velocity is proportional to than kt. Now if the graphs of $y = \epsilon^{-bt}$ and $y = 1-$ than kt are both plotted as shown by $y = f$ (than x) in Fig. 2 and the horizontal differences moved horizontally to the graph of $y = \epsilon^x\ (x+1)$, a new graph is obtained representing that for the motion with damping resistance proportional to v^2 and other power values may be obtained by inter-or extra polation.

Torsional vibrations

It will be realized that the foregoing results apply equally well by analogy to torsional vibrations by substituting I for m and 0 for s. One of the chief applications is in the design of indicating instruments, damping being introduced by eddy currents in an aluminium disc. Results apply also to torsional vibration in engines and transmissions.

Electrical oscillations

A full treatment is beyond the scope of the present article but considering an inductance (L), capacitance (C) and resistance (R) in series, L corresponds to m, $1/c$ corresponds to S and R corresponds to v. If the condenser is charged (q) and the circuit closed

$$L\ d^2q/dt^2+R\ dq/dt+(1/c)\ q = o$$

when the analogy becomes apparent.

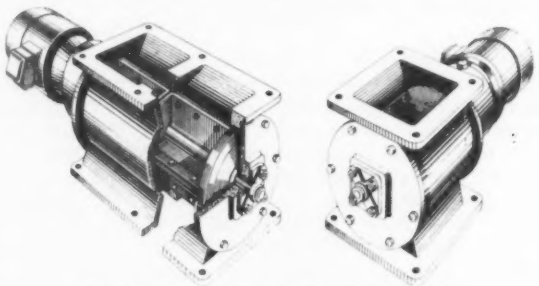
The charge q becomes s, the current i becomes v (or dy/dx) and the PD across the inductance becomes f.

The oscillation modulus becomes $1/LC$ and oscillation frequency $1/2\pi\sqrt{LC}$. The same formulae apply but $a = R/2L$ and $b = \sqrt{1/LC\sim(R/L)^2}$.

The time constant becomes RC.

Hopper Valve

A rotary discharge valve designed to provide continuous and free discharge of dust or fine powders from hoppers or bin outlets has been produced in a very compact form. It consists of a horizontal body with 8 in. square inlet and outlet flanges between which a 9 in. dia four-bladed rotor revolves on a longitudinal axis. The rotor is fully shrouded and a positive seal is obtained between it and the housing by means of renewable hard felt seals recessed into the main body casting. Complete gas and dust tightness is ensured by the stainless steel or neoprene rubber adjustable sealing and wearing strips which are fitted to the tips of the rotor blades.



Rotary discharge valve on cast iron or stainless steel

To save space the reduction gearbox forms one end cover of the valve body, eliminating the use of couplings or chain drives. The rotor is carried on the drive shaft of the gear unit, the drive being transmitted through a shear pin to prevent damage to the gearbox or to the motor in the event of overloading or jamming of the rotor. The unit is powered by a ¼ bhp totally enclosed fan-cooled, continuously rated squirrel cage motor which provides a rotor speed of 12 rpm. The valve is manufactured in cast iron or stainless steel as a single or duplex type unit, and the manufacturers are Dunford & Elliott Process Engineering Limited, Linford Street, London SW8.

Stelvetite Facing on Cubicles

Switchgear cubicles, fitted as they are with start and stop, isolating and selector controls, are subjected to constant usage which very quickly marks and scratches a paint finish. Baldwin & Francis Limited, of Sheffield, claim to have overcome this problem in their new range of multi-tier contactor switchgear by facing the front panels and facias of the cubicles with Stelvetite, plastic-coated sheet steel produced by John Summers & Sons Limited, of Shotton, Chester. Stelvetite, a P.V.C., laminated to high quality sheet steel, durable and easily cleaned, can be bent, formed, deep drawn and welded without damage to the plastic surface.

Each cubicle of a five-tier dust-proof switchboard made by the company is suitable for the direct on-starting of a motor of up to 200 hp, and each interior assembly can be withdrawn or completely removed for inspection and maintenance. A range of circuit breakers, switch fuse units, automatic slip ring starters and lighting transformers is also available in matching cubicles. Accordingly a composite switchboard of minimum dimensions can be manufactured.

Aluminium and Nitrogen in Steel

Most steel users have been taught in their early years that the role of aluminium in steel is as a deoxidant or 'killer', while nitrogen is primarily used as a means of giving steel of low carbon content a hard outer case, as in nitriding. We now know, however, that aluminium and nitrogen have other, subtler functions and effects. In the following notes, some outline is given of recent research into these

TWO of the primary factors in the breakdown of iron carbide or cementite in ordinary carbon steels are the amounts of aluminium and nitrogen present. Aluminium, for example, promotes the graphitization of the cementite, but nitrogen, if in large enough proportions, has the reverse effect. We know also that graphitization occurs as a result of the formation of nuclei and their enlargement, but what effects aluminium and nitrogen had on this was not known. Research was accordingly instituted to learn more of this.

The result is the discovery that the part played by aluminium in enhancing the graphitization of steel is that of a scavenger for nitrogen, which element in some way either stabilizes or prevents the breakdown of cementite. The amount of graphite formed in commercial steel is partly regulated by the previous austenitizing treatment, which establishes the amount of aluminium and nitrogen in solution.

Another fact metallurgists had known for a considerable time was that the grains in aluminium-killed low carbon sheet steel could be lengthened or equiaxed according to the composition of the steel, and particularly its aluminium content, and according also to the way it was worked before being cold reduced and annealed. Proof has now been obtained that aluminium nitride is of great influence in relation to the structure of low carbon steel sheet and strip made from steel that is killed with aluminium. To produce elongated crystals in such steels, there must first be a precipitation of aluminium nitride during the final annealing. The steel must, therefore, retain minimal amounts of aluminium and nitrogen in solid solution throughout the cold reduction processes. Since these conclusions were reached research has produced a great deal of metallurgical data on the way aluminium nitride behaves in low carbon steels. The mechanism by which precipitation of this nitride influences recrystallization and grain growth is important, and it is hoped that further research will throw even more light on this.

Aluminium is also not without importance in relation to tempering. It delays the contraction associated with the third stage of this treatment. Higher temperatures for tempering are, in consequence, necessary to achieve the third-stage decomposition in the presence of high aluminium contents.

Modern developments have rendered the heat-resisting and stainless steels of increasing economic importance, and those steels containing 12% chromium are particularly valuable. We still do not know all we need to know about the influence of alloying elements on these steels from the point of view of making them brittle. An investigation was instituted some time ago to study the impact properties of these steels as affected by aluminium content. A series containing varying amounts of different elements, including aluminium, at two levels of chromium was aged for 10,000 hr at 480° C (900° F) and it was then shown that 0·25% aluminium did not increase transition temperature after ageing. An important commercial application of these steels is to welded, corrosion-resistant linings in vessels employed at elevated temperatures in oil refineries and other chemical industries. Here the resistance to corrosion is sufficient, and the steels are less liable to embrittle by sigma precipitation at temperatures up to 480° C. Being made from annealed material, the steel containing the specified percentage of aluminium does not appear to embrittle during prolonged heating at the temperatures indicated.

We have earlier shown that the effect of nitrogen in preventing the graphitization of carbon steel has been investigated, and proved to exist. This discovery has suggested a number of possibilities, such as that of preventing the graphitization occasionally manifesting itself in the processing of parts made from cold-rolled, high carbon steel strip. These have been investigated, and it appears likely, though the results are not wholly conclusive, that there would be no graphitization of such steels during commercial processing.

A new field of research has received a great deal of attention in recent years. This is the economical production of materials able to support severe loads at high temperatures, but containing the least possible amounts of strategic, scarce or critical elements. Nitrogen has been found, when added (to the extent of about 0·5%) to a steel of 16% chromium, 14% manganese, 2% molybdenum type, to improve the hot strength and ductility at elevated temperatures. On the other hand, research has indicated that 25% chromium, 12% nickel stainless steels, as well as 25% chromium, 20% nickel stainless steels, are not greatly improved in corrosion resistance when slow cooling rates are used from the solution temperature when these temperatures are low and the nitrogen levels high. Low or commercial nitrogen levels appear, however, to improve corrosion resistance. When the steel has a low carbon content (0·06%) higher nitrogen content seems to increase intergranular corrosion resistance, but at higher carbon contents (0·16%), little improvement in this respect was observed.

As part of a wide inquiry into austenitic chromium manganese carbon nitrogen stainless steels, study was made of the influence of different heat-treatments, especially ageing treatments, on the microstructure and properties of these steels. It was discovered that a pearlite-like lamellar structure, indicative of a grain boundary reaction, was common in the high carbon, high nitrogen steels. This was studied, and it was found that

the nitrogen content had a marked influence on this reaction. Nevertheless, there was no evidence of nitrides in the steels, which contained about 0·4% carbon. However, after ageing to form grain boundary reaction products, X-ray diffraction tests revealed that the constituents precipitated out of solid solution were mostly chromium nitride. It was concluded, therefore, that the lamellar grain boundary reaction may consist of carbide and austenite or nitride and austenite, according to the amounts of carbon and nitrogen in the steels.

As a result of other investigations, it is generally accepted that carbon and nitrogen atoms in solid solution in *a*-iron cause strain-ageing. The minimum amount of either element necessary to produce a measurable degree of this may be 0·0004% nitrogen, but for carbon it has not been determined. Nitrogen has been found to promote strain-ageing at room temperature. The effect of increasing nitrogen from, say, 0·005% to 0·02% is to increase the hardness level of steel. The relation between hardness level and nitrogen content is approximately linear. However, the difference between the maximum hardness and the room temperature value remains fairly constant over this range of nitrogen content, so is not so good an index of strain-ageing as might be expected.

The austenitic high carbon, high nitrogen, chromium-manganese-iron alloys have been found to possess properties making them highly suitable for internal combustion engine exhaust valves, and one such alloy has a hot hardness at 760° C of 185 Brinell. Such alloys have excellent resistance to attack by the combustion products of leaded fuels and good resistance to stretch under high stress.

The addition of lead to steel produces low tool-chip friction, so that machining can be done at higher speeds with a better finish. Experiments designed to determine the influence of various elements on the machinability of these steels have revealed that nitrogen contributes to the work-embrittlement of steel. Added to a screw steel, therefore, it promotes a more favourable cutting action, and so gives better finish, chip properties and dimensional accuracy. It is probable that the level of nitrogen in any screw steel is a function of the tool-chip friction as well as the types of machining operations to which the steel is subjected.

In a 16% chromium, 2% nickel stainless steel, the addition of nitrogen, together with other modifications of composition, has been found to produce a banded retained austenite in place of banded free ferrite. This can present a real problem, because such bands are not readily removed by annealing. They are a consequence of segregation, and if allowed to remain satisfactory transverse properties are not obtained. There is reason to believe that the higher the nitrogen content the greater the amount of banded austenite formed. Longitudinal as well as transverse ductility is decreased by their presence.

Since 1940 the emphasis on studies of the austenitizing power of nitrogen has been on iron chromium nickel alloys in which nitrogen took the place of nickel to some extent. No trustworthy conception of the phase fields of this stem could be obtained from the published data, so that further work was instituted to determine the austenite – austenite + ferrite boundaries of the system, and to include in the study compositions higher in chromium and lower in nickel than previously investigated. It was also decided to ascertain the physical metallurgy of alloys of this system at between 700° and 1200° C.

Significant contributions to knowledge of these complex systems have been made as a result. In systems containing manganese, the principal effect of this element is to increase the solubility of nitrogen. The microstructures of solution-annealed iron-chromium alloys containing nickel and nitrogen change considerably by reason of nitrogen precipitation at temperatures below the optimum austenitizing temperatures. According to the degree of nitride precipitation, and the original composition, considerable quantities of martensite and ferrite may form. However, as the matrices of the alloys are not greatly depleted in nickel by such precipitation, they invariably retain austenite even after heavy precipitation of nitrides and carbides.

In rolling experimentally a number of chromium manganese nitrogen iron alloys, of austenitic type, cracking was experienced, and it was proved that a ductile to brittle transition existed. An investigation was therefore carried out to determine the influence of strain rate, test temperature and interstitial content, on this unusual embrittlement and its magnitude. It was found that as the nitrogen content increased, the ductility at low temperatures progressively decreased, while at intermediate temperatures the ductility-interstitial content relation passed through a minimum.

The diffusion of nitrogen along the surface areas of iron-chromium-nickel-nitrogen alloys in bars, when heated in a gradient furnace, has also been examined. It is concluded that nitrogen so diffused from the high temperature zone of the bar (1200°–1260° C) to the successively lower temperature zones (1180°–1150° C) has its maximum content in the 1070°–1120° C zone. An explanation suggested for nitrogen transfer is that at 1260° C the original nitrogen content of the two-phase structure exceeds the nitrogen solubility of this structure in equilibrium with the nitrogen pressure of the atmosphere within the tubes. Nitrogen is therefore lost to the atmosphere from the bar surface.

At the lower temperature end, nitrogen with smaller ferrite in the structure is less than that in equilibrium with the pressure in the tubes and is therefore absorbed from the atmosphere. Thus, the transfer of nitrogen occurs through the atmosphere rather than by surface diffusion. This explanation is generally regarded as sound.

Puncture Proof Insulators

In areas where lightning storms are frequent and surges of very steep fronts can be imposed on electrical conductors, punctures of the ordinary pin type of insulator can occur, and in coastal areas where salt deposits form on the insulators, frequent flashovers are sometimes experienced. To give an alternative design which overcomes these disadvantages a surge proof insulator, type BC46, has been produced by Doulton Industrial Porcelains Limited, Tamworth. This does not use a separate pin and is complete and ready for bolting to the cross arm. Any damage is readily seen as it must occur on the sheds, and the white surface of a break is clearly seen against the dark brown glaze. A long creepage length (14 in.) is exposed in its entirety to the washing action of natural rainfall. The makers claim that it is virtually impossible for the insulator to be punctured under any conditions. It is supplied with standard head size and fixings to suit steel or wood crossarms.

New Methods of Generating Electric Power

Thermoelectricity

applying the Seebeck effect to power generation

By STEPHEN J. ANGELLO

ALMOST 150 years ago the German physicist Thomas Seebeck discovered that the flow of heat through a metal segment could produce a voltage difference between its hot and cold ends. Although this Seebeck effect has since become familiar through its uses in instrumentation, the field of application has been severely limited because of its low voltage and power output.

Quite recently, the development of new thermoelectric materials has enabled us to raise both the power output and the efficiency of thermoelectric devices to levels suitable for the practical generation of power. A year ago, for example, we were working with devices whose output was slightly over 1 watt; today we have generators rated at 100 watts and very soon we will complete construction of a generator rated at 5000 watts.

The qualities of thermoelectric devices that have impelled these developments, particularly for military applications, include ruggedness and compactness and, of course, the fact that the devices are mechanically static. That is, heat is converted into electricity without the need for any moving parts. This freedom from moving parts has several significant implications for defence; for example, in military power plants heat could be converted to electricity without noise. In space vehicles and missiles, the absence of rotating parts would eliminate the gyroscopic forces that occur in rotating machines and so simplify guidance and stability in orbit. As more basic advantages still, the absence of moving parts means that thermoelectric generators are inherently more reliable than rotating machines and perhaps may eventually prove lower in first cost.

In any uniformly heated pellet of thermoelectric material its positive and negative electrical charges are uniformly distributed, as in Fig. 3, but when heat is applied to one surface, this distribution is no longer uniform. Although the positively charged ions in the crystals remain fixed, the negatively charged electrons tend to move to the cooler end, as in Fig. 4. This results in a gradient of electrical charge and a potential difference between the hot and cold ends which can cause current to flow in an external load. As we actually use thermoelectric devices, they are arranged in an array of series-connected thermocouples whose materials have been so formulated that their voltages are additive. It is through stacking of elements in arrays that we are able to achieve voltage outputs adequate for power generation.

One of the most important factors in the growth of thermoelectric technology is our ability to adjust the number of free electrons in semi-conductor materials. The importance of this is due to two basic relationships: First, the output voltage of any thermoelectric material is inversely proportional to the number of free electrons in that material; and, second, the conductivity of the material is directly proportional to the number of free electrons. Thus, insulators containing 10^{10} electrons per cubic centimetre generate Seebeck (output) voltages in the order of 10,000 microvolts per Centigrade degree of temperature difference between the hot and cold ends; offsetting this, however, is the fact that they have an extremely high internal resistance. On the other hand, the metals give Seebeck voltages of about 5 microvolt per degree but have extremely low internal resistance. To obtain maximum power output or optimum efficiency

It has been announced recently by Dr. S. N. Herwald, Vice-President—Research, Westinghouse Electric Corporation, that four new methods of generating electric power have been developed to the state where they appear to hold real promise as power sources for the future. This work is being pursued in new laboratories which John K. Hodnetle, Executive Vice-President, says doubles the company's research facilities. Dr. J. A. Hutcheson, Vice-President—Engineering, summarizes the four new methods as the fuel cell, the thermoelectric generator, the thermionic generator, and the magnetohydrodynamic generator. These operate at successively higher temperatures and raise entirely new problems in materials. The possible rewards are great however—high efficiency, low capital costs, and new possibilities in power generation, storage and use. In these articles members of the Westinghouse research team explain the preliminary stages of the work

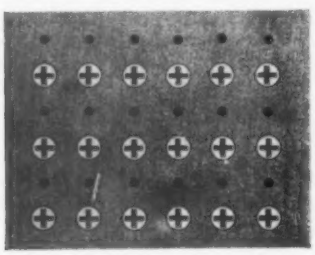


Fig. 3. (left)—In a uniformly heated material, the electrons and positively charged ions are uniformly distributed

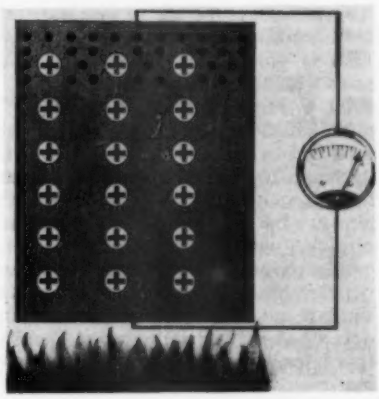


Fig. 4. (right)—Distribution of electrons and positively charged ions as it is influenced over a thermal gradient. Electrons concentrate at cold end of the specimen to cause a gradient of electrical charge. A potential difference is thus available to cause flow of current in an external load circuit

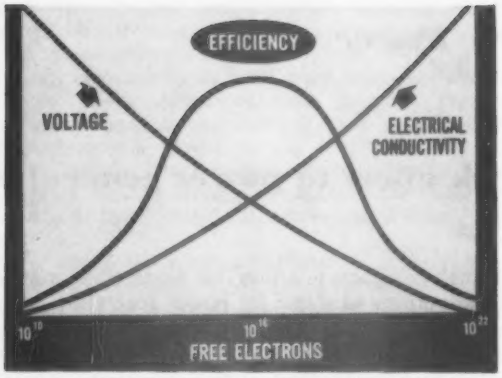


Fig. 5.—Curves showing the relationship between density of free electrons in a material. Conductivity and thermoelectric output (Seebeck) voltage. Optimum density for maximum power output is about 10^{19} electrons per cubic centimeter

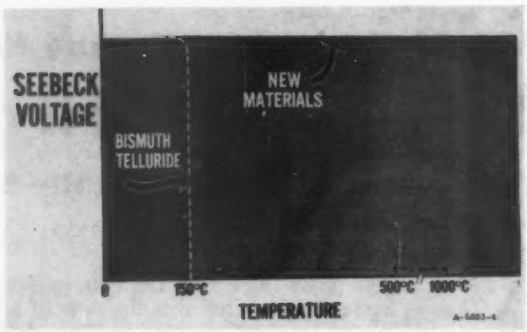


Fig. 6.—An illustration of the manner in which semiconductors become intrinsic at critical temperatures. In this extreme example, bismuth telluride's Seebeck voltage plummets to zero at 150° C

from a thermoelectric material we must therefore adjust the electron density for an acceptable compromise value between high voltage and high electrical conductivity. This is essential to the production of useful power since a combination of high voltage and low current or of low voltage and high current result in little power. The compromise is shown by the efficiency curves in Fig. 5 which show the optimum electron density to be about 10^{19} free electrons per cubic centimetre, a value well within the range of good-conducting semiconductors and one which affords Seebeck voltages of about 175 microvolt per degree C. Some typical materials which demonstrate acceptable efficiency are zinc antimony, lead telluride, bismuth telluride, and germanium telluride.

In thermoelectric generators built for practical uses we find it is desirable to use a number of different thermoelectric materials to take advantage of the fact that each has its best range of operating temperatures. This contributes to the increased efficiency that is possible when we operate generators at high temperatures. To cover low temperatures, say up to 600° C, we already have several semiconductors which have proved satisfactory, However to go higher, say into the 1000° C range, semiconductors are no longer suitable since at these temperatures they become "intrinsic"; that is, the heat input causes both positive and negative electrical charges to migrate in equal numbers and so no output voltage is possible. As an extreme example, we see in Fig. 6 how bismuth telluride's Seebeck voltage falls to zero at 150° C.

Obviously, at higher temperatures we require materials which are free of this behaviour. A promising step suggested by Dr. Zener, director of Westinghouse research laboratories, is the use of insulator materials which have been modified to become good thermoelectric materials. This is particularly interesting since many insulators exist which do not become intrinsic conductors in the 1000° C range. As an illustration of this modification, pure nickel oxide is normally an insulator but if it is modified by the addition of 3% of lithium, its resistivity decreases to about 0·01 ohm-centimetres. As explanation for this, in normal nickel oxide the nickel has a valence of plus two but the addition of lithium causes the appearance of nickel with valence of plus one. The greatly increased conductivity is brought about by an exchange of charges between plus-one nickel and plus-two nickel. It is through similar modifications that other materials are being developed for use at higher temperatures. For example, this approach led to one of our newest mixed valence materials, samarium sulphide, which has a good figure of merit at temperatures as high as 1100° C.

Despite these developments, our increasing knowledge of semi-conductors or mixed valence materials does not solve all problems of thermoelectricity for after all, materials are not an end in themselves; they must be fabricated as thermocouples and then be assembled in finished devices. For example, assemblies of thermoelectric materials must be joined so that contact resistance will not be excessive for this would have the same effect as high internal resistivity of the material and would reduce the efficiency. Also, above 300° C, it is necessary for thermoelectric materials to be shielded from the air to prevent corrosion of materials and joints. Another aspect of design is the need to mount thermoelectric devices so that they will withstand shock and vibration. One method we have used for accomplishing this is to apply compressive forces through spring-loading.

Turning now from the design of thermocouples to the design of complete generators, we are able to draw some interesting conclusions regarding the relationship between power and weight in equipment of the near future. In one of the first generators to be built for the Rome Air Development Centre, we produce 100 W from a 50 lb unit cooled by free convection, for a power-to-weight index of two-to-one. Since performance can be improved considerably by using forced convection of air or water to reject heat, we believe it feasible for generators designed in this way to produce 15 W per pound of weight, for a power-to-weight index that is comparable to that for a typical, petrol engined 500 W generator.

Other design problems with high priority grow out of our desire to narrow the gap between the efficiency that is theoretically available from known materials and the efficiency that is actually available when these materials are used in equipment. Materials available to us today are capable of an efficiency of about 17% but when assembled as elements of complete generators, the overall efficiency then becomes about 6%. Much of this loss of efficiency is due to such factors as the stack losses represented by the discharge of heat-bearing gases from the generator's "chimney" and the fact that some of the energy transferred through the walls of the chimney passes around but not through the thermoelectric elements.

Although continued progress in generator design will reduce losses and increase total efficiency, it seems certain that nuclear reactors will be much more efficient in thermoelectric applications than conventional heat sources. With nuclear reactors, it will be possible to have the heat source completely surrounded by thermoelectric

elements to eliminate stack losses.

One of the most interesting aspects of the efficiency of the thermoelectric generator is that it is independent of power rating, which is, of course in contrast to the power-efficiency relation for conventional machines. Small conventional power supplies have an efficiency of roughly 5%, the automobile engine is about 15% efficient, and large diesel engines and marine steam turbines have efficiencies of about 20%. Our most efficient units, large central station power plants have efficiencies of about 42%. At present, the efficiency of today's thermoelectric generators is constant at about 6% regardless of rating. Viewed from the standpoint of efficiency only, thermo-electric devices are thus comparable to conventional power sources in applications up to about 10 hp.

As new materials are developed, it seems likely that in about five years we will have materials with an inherent efficiency of 30% and we see no reason to regard this 30% as an ultimate ceiling. At the same time, it appears that to achieve efficiency much above this level a major breakthrough will be necessary. As we work with the 30%-efficient materials we foresee for 1965, we believe now that we will be able to construct generators with over-all efficiency of 20%, an efficiency level at which there would be many important applications for thermo-electric generators operating in the 1000 kW range.

In addition to certain military applications of thermo-electric generators which are expected to materialize, there are commercial applications that appear feasible in the near future. One of these is a thermo-electric power supply for communication and instrumentation equipment at locations along natural gas transmission lines where pipe lines and power lines are widely separated. Another similar application is thermoelectric power supplies for cathodic protection of oil well and pipeline equipment. Power requirements for such applications range from several watts to about 100 W and are well within the capacity of today's technology.

Applications involving larger power levels will, of course, depend on an increase in the efficiency of thermo-electric power generation, but it is possible now to visualize thermoelectric power supplies in which a nuclear-reactor-energized thermoelectric generator included within the pile but equipped with external cooling loops would approach an over-all efficiency of 20% for ratings in the megawatt range.

Diverter Valve

A diverter valve for either manual or electro-pneumatic operation is now being manufactured by Thomas Robinson & Son Limited, Rochdale. The valve has been designed for use in the company's Pneu-Flow pneumatic conveying system, for diverting powdered or granular material in blowing lines. It will be included in both small plants and fully automatic plants of the type which the company is now installing in the U.K. and overseas.

The valve can be supplied in various bore sizes, and single solenoid valves with spring returns, or double solenoid valves which can remain in either position indefinitely, are available. An adjustable cushioned end-cap is fitted to valves required for very high speed operation, and a solenoid control valve is also available which allows air to enter the cylinder at a faster rate.

The valve consists of a cast iron casing with an inlet bore and two outlet bores, the latter dividing at an angle of 40°. Steel sleeves, rolled into the cast iron of the cylinder body, enable a tight connexion with the blowing lines to be made by the use of air seal couplings. A piston, located axially by end-caps, and radially by a stud, is fitted in the cylinder. The piston has two ports and by changing its position in the cylinder the conveying air and stock passes through either one or the other to the appropriate outlet bore.

Rubber O-rings are fitted to the piston to maintain a seal between the blowing lines and the cylinder ends, thus preventing air from the end-cap leaking into the blow-line. This is, in any case, a remote contingency since the valve is machined to very close tolerances.

The piston is moved by compressed air, admitted through the end-caps. A piston valve, electrically operated by a solenoid, admits compressed air from the air-line to the required cylinder end, and in the same operation exhausts the air from the opposite side of the cylinder. The air pressure required is 60 psi.

Micro-switches can be fitted to the cylinder cap ends to provide visual or audible indication that the piston has moved to one or the other position, or to incorporate the valve into the plant control system for the operating sequence. Each switch is actuated by a plunger which is depressed when the piston moves into position.

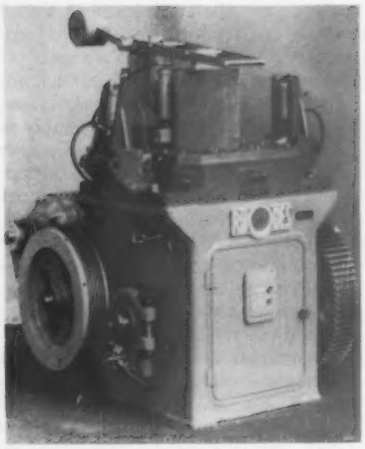
Manual control valves are fitted with a handwheel or chainwheel according to the need. A screwed rod, tapped and locked into the piston, passes through a sleeve nut located in the end-cap. By revolving a hand-wheel fitted to this sleeve nut the screw is caused to pass up or down the nut, thus moving the valve between the two positions.

Tie rods, which clamp the end-caps to the cylinder ends, are used to mount the valve in any required position on the supporting steelwork. Provision should be made in the compressed air line for adequate water traps and oil lubricators as it is imperative that the water content of the air supply is kept to a minimum.

Quenzine Quench Oils

Quenching oils containing Quenzine—a formulation of wetting oils and other ingredients developed in the U.S.A. by Aldridge Industrial Oils, Inc.—are now being made in Britain and marketed by the Electric Resistance Furnace Company Limited, Netherby, Queens Road, Weybridge, Surrey. The oils are claimed to give greater hardness to oil hardening steels and to give a deeper case more quickly. In the initial and intermediate temperature range they have very much increased cooling power, but below 370° C the cooling rate reduces rapidly to permit gradual transition to martensite, thus combining maximum hardness with minimum distortion, strain and cracking. It is claimed they show little if any deterioration over long periods of hard usage.

Quenzine, once mixed, becomes an integral part of the quench oil and will not separate, has no preferential dragout, contains no soaps or fats and is not affected by filters. It does not hold water but allows moisture to settle and to be drained off from the bottom of the tank. The oils are supplied in three grades, K9 for use at 130°–180° F, K150 for use at 225°–300° F and K300 for marquenching at 325°–400° F. At 100° F, K9 and K150 have viscosities of 90 and 190 S.U.S. respectively. K300 has a viscosity of 90 S.U.S. at 210° F.



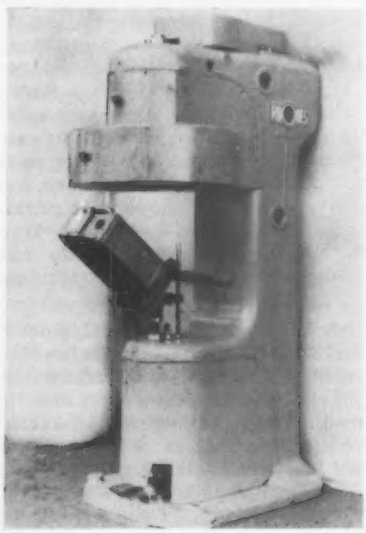
Squeezer flanging and beading machine for can bodies

Can Making Machines

Two Rhodes machines specially designed to meet specific requirements are a squeezer type flanging and beading machine for rectangular can bodies, and a double seaming machine for the tops and bottoms in which the can remains stationary during the seaming operation.

The incorporation of compressed air equipment gives sequential operation by which the machine starts as soon as the can is in the correct position.

Feeding of cans to the irregular double seaming machine is greatly facilitated by the tilting motion of the bottom pallet.—Joseph Rhodes & Son Limited, Wakefield, Yorks.



Double seaming machine for can tops and bottoms

Self-locking Spring Pin

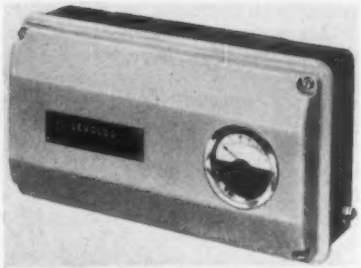
A new self-locking carbon steel spring pin named Sel-lok is now being marketed by the Unbrako Socket Screw Company Limited, Burnaby Road, Coventry. A cadmium plated product, it is already being used in the assembly of cine projectors, switch gear, safety axes, pulleys and even fishing reels.

Sel-lok spring pins are ideal for applications of this type. No costly equipment required, just drill the hole and drive in the pin. Below a small proportion of the Sel-lok range in varied sizes from $\frac{1}{16}$ in. × $\frac{1}{16}$ in. to $\frac{1}{2}$ in. × 4 in.

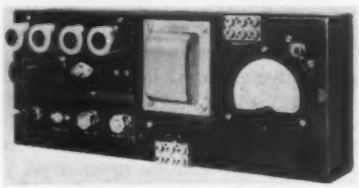
The chief feature is the ease of installation. It is simply necessary to drill a hole and drive in the pin, no additional equipment being required. Chamfered ends allow easy driving and the bevelled slot edges prevent scoring. Another advantage is that it can be removed and refitted many times without damage to the pin or the assembly. When used as a pulley axle, the spring action of Sel-lok has a cushioning effect which, if not required, can be reduced or removed entirely by inserting a further spring pin inside the first.

Continuous Level Indicator

The Levolog continuous level indicator has been designed for the continuous measurement of almost any material stored or contained in silos, tanks, hoppers, etc. The instrument is capacitance operated,



The new 'Levolog' continuous level indicator type CCL300. The chassis is shown below



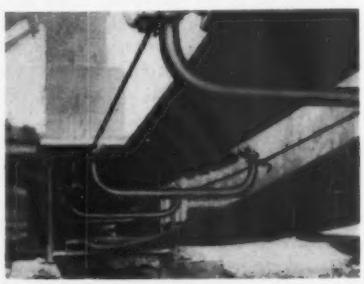
the control unit being used in conjunction with an electrode system fitted into the container and the incremental change of capacitance caused by the material rising or falling in the container operates an indicating instrument.

Basically, the equipment consists of the control unit housing the electronic equipment, a stabilized power unit and a calibration meter visible at all times through a window in the lid of the case; the electrode system; and the main indicating instrument basically a d.c. milliammeter provided for local or remote indication as required.

The indicator is housed in a specially designed robust cast iron case the lid of which is fitted with a rubber gasket making the enclosure dustproof and weatherproof. Manufacturers are Thomas Industrial Automation Limited, Station Buildings, Altrincham, Cheshire.

Rope Belt Conveyor

A new rope conveyor system announced by Joy-Sullivan Limited of Cappielow, Greenock, comprises flexible Limberollers mounted in



The Joy Limberope rope belt conveyor offers a simple speedily set up conveyor system for temporary or permanent installations

rigid, tubular steel cradles, which in turn are suspended at each end between parallel wire ropes. These stringers are held at the required height by chains attached to stands, which carry integral return idlers. Quick-release handle-bolts on the cradle bracket and support stands and the low tension required on the wire stringers between anchor points enable the system to be quickly set up, dismantled and relocated.

The intrinsic design of the system permits insertion of Limberollers and support stands at wide intervals —Limberollers from 4 to 9 ft, stands from 12 to 40 ft—depending on the load carried—and caters for densities up to the 150 cu ft/lb class. The system can be applied to any belt width from 16 in. to 36 in. wire rope varying from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. to cope with the extremes. The flexible idler in its swivel mounting conforms to the load, and provides a cushioned ride which absorbs shock and surge loadings. There is no pinching and there are no projections to rip the belt and the troughing catenary exerts a self-centring action on the material, largely preventing spillage and underbelt material build-up. Two bearings only carry the idler, instead of the usual six, and are of the self-lubricating sealed-for-life type, situated well above the dirt zone.

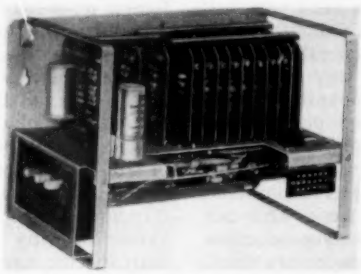
Precision Pulse Source

A new all-electronic precision pulse source, the A.T.E. crystal chronometer, with a time interval accuracy of the order of a few seconds per annum, and contained within a small physical unit, is now being produced commercially and is marketed by Communication Systems Limited, Norfolk House, Norfolk Street, London WC2.

The chronometer employs a crystal-controlled oscillator to generate a basic frequency which is fed to a series of binary dividers. The outputs of the binary dividers are fed to separate pulsing relay circuits to produce pulses at the required intervals. The special circuits are completely transistorized and make extensive use of printed circuit panels of the plug-in type.

The standard chronometer for general application produces three square wave pulses at intervals of 1, 30 and 60 sec respectively, but other pulse output rates can be provided. Frequency stability is achieved by

This crystal chronometer is in an anodized aluminium case 12 in. × 8½ in. × 7⅛ in. It appears below withdrawn from case and the plug-in printed circuit panels can be seen



operating the crystal over a particular part of its characteristic, and where the temperature variation is excessive, the chronometer employs a thermally compensated crystal oscillator. Its accuracy is not affected by vibration or movement. Standard models operate on 24 volts d.c. but chronometers for mobile use can be produced to operate on other voltages.

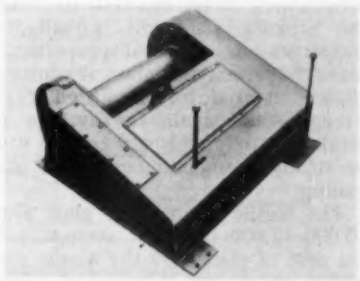
Wakefield-Dick "SG" lubricator for self-levelling greases

Lubricator for Self-levelling Greases

A new grease lubricator, the "SG", has been introduced by Wakefield-Dick Industrial Oils Limited. It is a positive action lubricator designed specifically for the pumping of self-levelling greases and shows a considerable first cost saving against all-purpose grease lubricators which are necessarily more complicated in design.

The new lubricator is compact but robust, has a grease capacity of 8 lb and is fitted with up to six outlet connexions. It can be supplied with a plain drive shaft or the drive can be arranged through a sprocket, pulley or ratchet. Alternatively the lubricator can be fitted with its own worm or ratchet reduction gearbox in order to take advantage of higher driving speeds.

A complete installation, comprising the lubricator directly coupled to a fractional-horsepower geared motor and mounted on a mild steel baseplate can also be provided.



The newly designed Felco electric powered winch is of all-steel construction and has many interesting features

All-steel Winch

A new range of electric powered winches has recently been announced by Felco Hoists Limited, 29 Cromwell Road, South Kensington, London SW. Available in capacities from 2 to 12 ton, these winches, of all steel construction, are of entirely new design, having no bed-plate or platform. All parts of the mechanism are fully enclosed, the absence of exposed parts making the equipment weatherproof.

All the gears run in oil baths and are mounted on ball bearings. An interesting feature is the electro-hydraulic main brake, in addition to an auxiliary foot brake for controlling the load when operating the winch in the drum idling position.

Polyester Glass Plastic Laminates

An examination of physical properties with data on mechanical strength

GLASS fibre reinforced plastics have been variously described as 'as strong as steel', 'a strength/weight ratio better than dural', and similar generalized terms which, in specific performance for any particular stressed design application, are largely meaningless. The designer contemplating glass reinforced plastic as a possible structural material may therefore be tempted to classify performance as 'doubtful', and where there is a definite case for using the material, to assess the laminate thickness required on a trial and error basis. This can, quite easily, lead to an unnecessarily costly production, the common trend being to employ unnecessary thicknesses of laminate and hence an undue weight of glass.

Trial and error methods, or 'guesstimates', based on previous experience with the material are, however, quite satisfactory for average non-critical applications, where adaptability of the material to complex shapes, etc., is the primary attraction. Equally, corrosion resistant properties, or electrical properties, may be sufficient alone for specifying glass reinforced plastic as a first-choice material for a particular project. As regards strength—and again for average applications—if the resulting moulding is stiff enough it will almost certainly be strong enough in tension or other likely forms of loading.

The tensile strength of glass alone is quite high—10,000–15,000 psi is an average, safe design figure. In the case of glass *fibre* the tensile strength is very much higher and figures in excess of 1,000,000 psi have been realized on single filaments under laboratory test conditions. Apart from the fact that the drawn filament form of material is usually stronger than 'solid' stock (in just the same way as drawn steel wire has a higher tensile figure than the original steel from which it was fabricated) the absence of stress raisers in the form of surface scratches, etc., inherently implies a better mechanical performance.

Nothing like the ultimate performance of glass fibre can, however, be realized in a glass plastic laminate. The glass fibre, in the form of a cloth or mat, is the reinforcing material, bonded with a suitable 'wetting' resin (most commonly ployester resin) of lower strength. The resulting strength of the final laminate is therefore dependent on the original form of the glass fibre, the type of resin and the presence of fillers, etc., as well as the technique employed in laying up (which governs both the glass/resin ratio and the thickness of the final laminate). Also, working conditions may materially affect the final strength. The presence of moisture or other inhibitors which can delay or even prevent full setting of the resin, evaporation at the surface of the laminate leading to loss of monomer, ageing effects, etc., can all lead to widely varying mechanical strength figures. Hence strength figures obtained by practical tests can show considerable differences under varying conditions of manufacture, and even with similar conditions of manufacture and different operators.

The only suitable method for analysing the mechanical performance of a glass plastic laminate is on the basis of *glass content* in the finished laminate and not on the basis of laminate *thickness*. Such data are still subject to some of the other limitations just mentioned, but applied to a standard or specific production technique should yield figures showing a good measure of consistency. Rather than specific figures, however, performance will still be expressed over a range—the lower figures typical of good average workmanship and production control under satisfactory workshop conditions, and the higher figures ultimate performance which could be achieved working to strict material specifications and strict production control.

In more general terms, the mechanical performance of glass plastic laminates is often expressed on a comparative basis against other typical structural materials—see Table I. The figure for ultimate tensile stress quoted here is high for average practice but the most interesting feature remains that the strength/weight ratio is very favourable and even at half strength—consistent with figures which should readily be achieved with glass cloth laminates on a production basis—is still at least equal to a good quality steel. Apart from that, however, such a table of comparative performances has little significance from an engineering point of view.

The main limitation from an overall strength point of view is strength in bending. Table II gives typical performance figures for chopped strand mat and cloth laminates assessed over a number of years production experience, the lower limits of which we would assess as

Table I.—COMPARATIVE PROPERTIES

Property	Polyester/ Glass Cloth Laminate	Polyester/ Glass Mat Laminate	Steel	Dural	Structural Timbers
Specific gravity	1·75	1·6	7·8	2·8	0·5—0·8
Tensile strength psi	50,000	30,000	100—125,000	65,000	10—20,000
Young's modulus (psi)	$2·8 \times 10^6$	—	29×10^6	10×10^6	$1·4–2·3 \times 10^6$
Strength/weight Ratio	29·4	18·8	14—16	23·2	20—25

Table II—TYPICAL PRODUCTION STRENGTH FIGURES *

Property			Glass Fibre Reinforcement	
			Chopped Strand Mat	0·009 in. Cloth—Square Weave
Glass content	% wt.		20—30	40—60
Tensile strength		psi	11—29,000	20—40,000
Compressive Strength		psi	17—28,000	25—35,000
Flexural "		psi	15—25,000	25—40,000
Tensile modulus "	10^6	psi	0·7—1·5	1·2—2·0
Flexible "	10^6	psi	0·3—1·0	0·8—2·0

*Bondaglass Limited

more typical of amateur or unskilled production rather than normal professional experience. It will be noticed how directly mechanical strength is related to glass content, the mat forms—attractive from an economic point of view since glass mat is about half the price of cloth—necessitating a very much higher resin content. The point of economy must not be confused by this higher resin content for resins can be bulked with fillers and mat lay-ups still remain by far the more economic production.

Table III then details typical laminate thicknesses for properly wetted-out mat and cloth laminates which can be taken as average figures achieved in practice. The point of significance here is the difference in laminate thickness which can be anticipated with the older types of mat and the more modern treated mats where the binders have been developed specifically to promote wetting out and thus achieve a much higher glass weight in the finished laminate. Consequently the resulting laminate may be both stronger and thinner, illustrating the fallacy of assessing laminate strength on thickness. Thickness, of course, can also be modified by lay-up technique and the use of fillers both in the resin and resin/fillers mixes as 'stopper' layers for arriving at bulk quickly and cheaply and providing a working surface for flatting off at intermediate stages of construction.

Specific bend strength figures for test samples of chopped strand mat are given in Table IV, together with stiffness data of the load required to produce a deflexion of 0·1 in. Both breaking load and stiffness show an increasingly favourable ratio with increasing glass weight in the final laminate—see Fig. 1. Stiffness, in fact, is almost directly proportional to (glass weight)^2 and breaking load very near so with increasing glass weight—see Figs. 2 and 3.

This emphasizes the previous comment that, for average purposes, if the laminate is stiff enough it will almost certainly be strong enough in both tension and compression. The weight of glass which must be added to achieve a desired degree of stiffness immediately implies a substantial increase in tensile and compressive strength figures.

This may not necessarily be good design practice, for the resulting products may be unnecessarily heavy, costly and excessively strong. Adequate stiffness may be achieved by other means, such as by moulded-on stiffeners

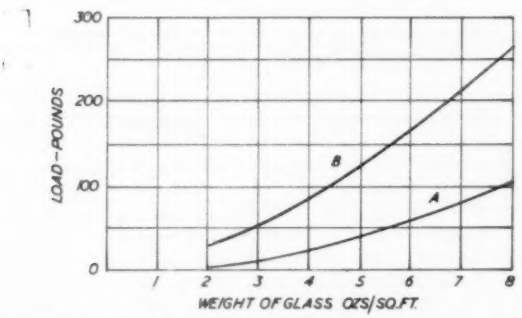


Fig. 1.—Stiffness curve A, representing load to produce 0·1 in. deflexion on test beam

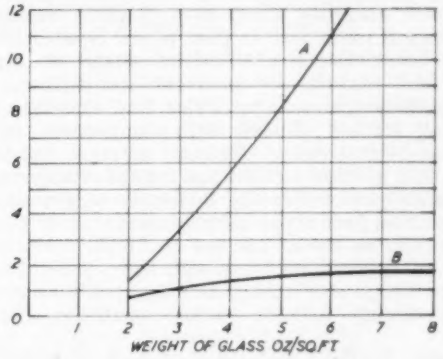


Fig. 2.—Stiffness plotted against glass weight—curve A for load/weight of glass and curve B for load/(weight of glass)^2

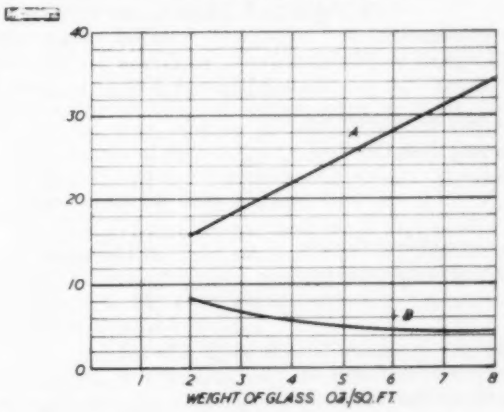


Fig. 3.—Bending strength/glass weight, curve A, and bending strength/(glass weight)^2 curve B

Table III.—THICKNESS OF LAMINATES

Reinforcing material	No. of layers	Glass weight	Resin weight	Laminate weight	Approx Laminate thickness
		oz/sq ft	oz/sq ft	oz/sq ft	in.
1 oz mat*	1	1·0	4·5	5·5	1/20
,,	2	2·0	8·0	10·0	1/10
,,	3	3·0	12·0	15·0	3/20
1½ oz mat*	1	1·5	7·0	8·5	3/40
,,	2	3·0	12·0	15·0	3/20
,,	3	4·5	18·0	22·5	1/8
2 oz mat*	1	2·0	8·0	10·0	1/10
,,	2	4·0	16·0	20·0	1/5
1 oz mat†	1	1·0	2·7	3·7	·030
,,	2	2·0	4·8	6·8	·050
,,	3	3·0	7·2	10·2	·100
1½ oz mat†	1	1·5	4·2	5·7	3/64
,,	2	3·0	7·2	10·2	5/64
,,	3	4·5	10·8	15·3	1/8
2 oz mat†	1	2·0	4·8	6·8	3/32
,,	2	4·0	9·6	13·6	·055
0·010 in. Cloth	1	0·8	1·2	2·0	·020
,,	2	1·6	2·0	3·6	·038
,,	4	3·2	3·6	6·8	·055
0·015 in. Scrim	1	1·0	2·0	3·0	·035
,,	2	2·0	3·0	5·0	·050
,,	4	4·0	5·5	9·5	·080
Surface mat	1	·075	1·0	—	—

* Old type binder. †New, improved binder

Table IV.—STRENGTH IN BENDING *

Material	Specimen: 9 in. × 2 in. beam, span 6 in. supported both ends	
	Stiffness	Breaking load
	Load, lb to produce 0·1 in. Defln.	lb.
2 ounces of mat/sq ft	3	32
3 ,, ,,	10	57
4 ,, ,,	22	90
5 ,, ,,	44	130
6 ,, ,,	66	170
7 ,, ,,	87	213
8 ,, ,,	108	274

* Mitchell & Smith

or the use of sandwich construction. One can then design down to a required tensile or compressive strength figure, as appropriate, and so control the laminate weight and cost in this way, and add further stiffening as necessary.

Whilst the use of stiffening sections is obvious, application of sandwich construction to glass plastic laminates is less well known. There are low density expanded materials which have excellent adhesion to the types of resins used in glass plastic construction and offer considerable mechanical advantages if employed as a core material for sandwich construction. Rigid polyurethane foams, in particular, have a useful application on account of their high compression strength. Various other types of 'foamed' materials can also be used, such as foam rubbers and expanded polystyrene—the latter particularly for minimum weight sandwich construction since expanded polystyrene can be produced at densities as low as 2 lb per cu ft. The surface must, however, be protected—e.g. with epoxy resin. Cellulose acetate foams also cannot be employed with polyester resins directly without surface treatment and even expanded rubber may have a surface 'skin' which has just to be removed by mechanical means. Polyurethane foam is a first choice material for sandwich construction with polyester resins.

Typical test figures achieved with 7·5–8 lb per cu ft polyurethane foams and chopped strand mat laminates are summarized in Table V and also illustrated in Figs. 4 and 5. The spectacular increase in stiffness obtained at low glass weights is readily apparent by comparing with Table IV. It is also noticeable that with reinforcing layers of comparatively low strength there is a definite limit to the thickness of foam, beyond which no worthwhile gains are achieved.

A further interesting point is that a sandwich laminate can be designed for maximum economy with regard to the direction of loading. In bending, obviously one surface of the laminate will be stressed in tension and the other in compression. In the case of mats the compressive strength is generally superior to the tensile strength, hence less thickness should be required on the 'compression' side than the 'tension' side of a sandwich for balanced performance in bending (i.e. both sides failing together). This is born out by the test figures which show very little increase in strength with an extra layer of 1 oz mat on the 'compression' side. Thus with a subject stressed in bending the designer can obviously analyse the loading to arrive at an optimum specification which utilizes the minimum of laminating material. With cloth laminates there is less likely to be such a difference in surface layer strength under stressed conditions, but here the type of weave must also be considered.

Table V.—POLYURETHANE FOAM SANDWICH LAMINATES*

Construction		9" × 2" beam, 6" long, supported both ends	
		Stiffness	Breaking load
	Core thickness	Load, lb to produce 0·1 in. Defln.	lb
Skin A 1 layer, 1 ounce chopped strand mat Skin B 1 layer, 1 ounce chopped strand mat	¼ in.	37	79
	½ in.	81	142
	¾ in.	89	148
	1 in.	101	148
Skin A 2 layers, 1 ounce chopped strand mat Skin B 1 layer, 1 ounce chopped strand mat	¼ in.	55	106
	½ in.	97	209
	¾ in.	135	258
	1 in.	148	283
Skin A 2 layers, 1 ounce chopped strand mat Skin B 2 layers, 1 ounce chopped strand mat	¼ in.	57	139
	½ in.	96	205
	¾ in.	135	258
	1 in.	179	287

*Mitchell & Smith

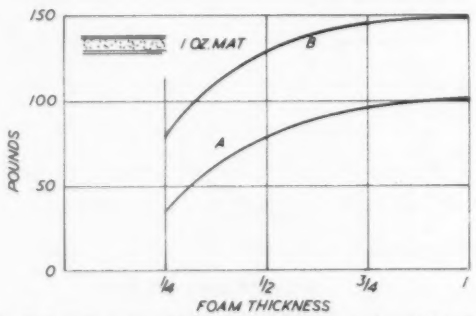


Fig. 4.—Stiffness curve A, and bending strength B, for simple sandwich. Stiffness defined as load to produce 0·1 in. deflexion on test beam

Table VI.—AVERAGE LAMINATE CHARACTERISTICS *

Property	Rod rovings	Scrim cloth	Square weave cloth	Chopped strand mat	Diamond mat	Woven rovings
Specific gravity	1·9	1·85	1·7—1·8	1·5—1·6	1·6	1·7
Glass content % wt	70	65	60	30—60	65—70	50—60
Tensile strength psi	120,000	20—35,000	30—50,000	17—25,000	50,000†	20,000
Compressible strength psi	70,000	25—30,000	35,000	18—25,000	—	30—45,000
Bend strength psi	150,000	25—30,000	40—60,000	30,000	55,000	40,000
Shear strength psi	—	—	14—19	12	—	—
Impact strength (unnotched) ft lb/in.²	70	20—25	25—40	20	20	—
Water absorption % in 24 hr	0·15	0·20	0·15	0·50	—	0·4—1·0
Coefficient of linear expansion per °C	15×10^{-6}	$8—10 \times 10^{-6}$	10×10^{-6}	12×10^{-6}	—	$7—9 \times 10^{-6}$
Thermal conductivity btu/in./sq ft/hr/°F	3·0	2·0	2·0	1·7	1·7—1·8	1·5—2·0

* Sources—Various. Taken as summary of average of typical figures
† Uni-directional only

Table VII.—LAMINATE MATERIAL PROPERTIES

Property	Unfilled Polyester resin	Reinforcing materials				
		Glass Cloth	Asbestos Fibre	Terylene	Nylon	Cotton
Specific gravity	1·3	2·55	2·4	1·4	1·14	1·5
Tensile strength, 10^3 psi	5	400	250	80—120	60—100	60—70
Compressive strength, 10^3 psi	20	—	—	—	—	—
Bend strength, 10^3 psi	12—13	—	—	—	—	—
Tensile modulus, 10^6 psi	0·3	—	—	—	—	—
Moisture absorption, % in 24 hr	0·4	—	—	—	—	—
Youngs modulus, 10^6 psi	—	10·5	15·0	1·7—2·4	0·34—0·64	0·9

Of the numerous cloth weaves available a number are deliberately patterned to give maximum tensile strength in a certain direction. Such uni-directional cloths would be laid up so that the direction of tensional loading corresponded to the preferred direction of the weave. It does not necessarily follow that there is a similar 'preferred' direction for compressive strength—although this would normally be in the same direction when the main strands are stressed as columns—and so one could arrive at various combinations of surface layer thicknesses in cloth-sandwiches.

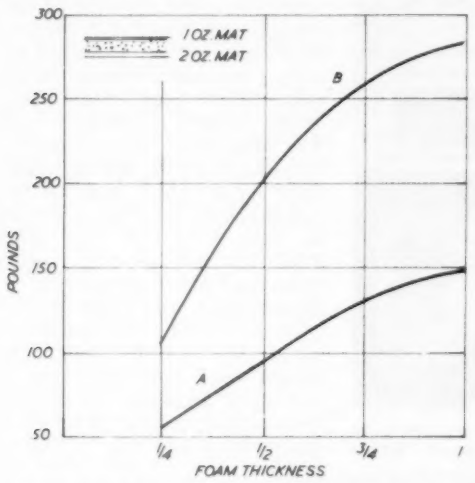


Fig. 5.—Stiffness curve A, and bending strength B. Stiffness defined as Fig 4. Bending load applied so that the thicker mat layer is in tension

Uni-directional rods, sometimes referred to as rod rovings, may achieve tensile strength figures as high as 120,000 psi, although 70,000 psi is a more general—and safer—design figure. This strength figure is due entirely to the rod-like formation of the material, with other mechanical properties similarly enhanced. These must not be confused with *woven* rovings which, in cloth form, yield laminates of lower strength than normal cloths because of the greater bulk of individual strands, although showing a better strength than mats. The uni-directional cloth weaves basically employ thicker strands running in the preferred direction, the required direction of lay being more or less obvious from the appearance.

As a general guide Table VI has been prepared showing typical performance figures for different types of laminate in cloths and mats; and also strength figures for the resins alone in Table VIa. For a critical application it would be necessary to prepare a number of specimen test pieces with the form of laminate visualized, duplicating the production method to be employed, and arriving at suitable design figures from these results.

The effect of fillers cannot be discussed fully in general terms. Provided they are completely non-inhibiting, however, the resin strength is usually little affected, except that compressive strength and hardness should be increased. The right type of filler, by considerably bulking the resin, can add greatly to rigidity, usually at the expense of making the final product more brittle.

A further point which is deserving of mention is that although a laminate may apparently set hard in a comparatively short time, complete curing may not take place for several days or even weeks after. Thus the full performance of the laminate may not be realized until after a satisfactory period of ageing. In the main, however, this affects weathering characteristics, and particularly water absorption.

Laminates designed to have minimum water absorption are fabricated from Grade—E glass (low alkali, electrical grade), which is now the standard form of glass used for glass fibre manufacture anyway. Water absorption with a properly cured laminate should then be a negligible figure—of the order of 0·16%, but possibly up to ten times this figure if continuously submerged.

As yet there are no standard techniques established for testing the 'cure' of a laminate, except that water absorption tests can provide a good guide. Measurement of dielectric constant or power factor could be another useful criterion as the latter also tends to stabilize at a minimum figure when the cure is complete. Artificial ageing, sometimes called post-curing, can be employed to hasten stability, which basically consists of heating the laminate for a period of two or three hours at a temperature of 80° C. The significance of the degree of cure and the time which may be required for complete ageing with cold lay-up technique also stressed the advantages that hot moulding techniques may offer for critical productions.

New Vacuum Gauges

The Instrumentation Division of Associated Electrical Industries Limited has completed the re-design of the "Metrovac" high vacuum gauges, the new range being notable for its effective combination of those features important to the design of industrial and laboratory high vacuum systems. The range includes ionization, Penning, Pirani and thermocouple gauges covering the pressure range 10^{-9}mm to 1mm mercury.

The gauge heads for the new range are small, robust and demountable; they are metal-encased, and have been specially designed so that wearing parts can be replaced at little cost. The elements in particular can be replaced *in situ* quickly and easily.

Each control unit gives a direct reading. The control equipment is compact and is mounted for ease of maintenance on a panel which slides into a portable pressed metal case. Alternatively, the unit can be mounted in Post Office type racks, a series of adoptor panels being available for this purpose.

Vacuum pipework connections have been standardized, with corresponding reductions in cost.

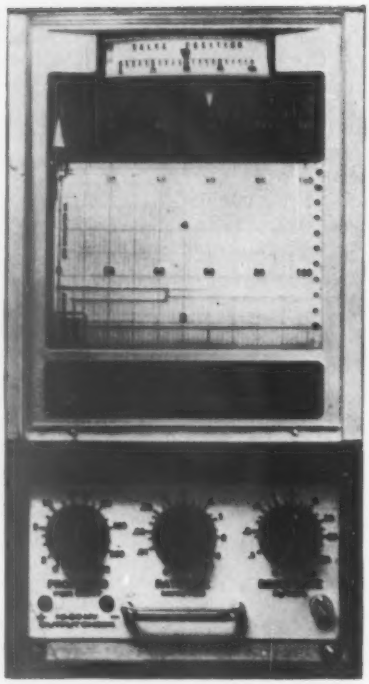
Air Compressors

The Joy-Sullivan Air Power Division, London, which was formed last year to manufacture a range of air compressors and pneumatic tools is making an industrial stationary compressor which is a two-stage double-acting water-cooled machine of V-vertical design. It is powered by a flange-mounted electric motor and is one of a range available offering capacities from 40° to 835 cfm free air delivered at 100 psi. Low pressure models operate at 60 psi with proportionately larger capacity. For the special needs of certain processing industries there is also in the range an oil-free version in which carbon-graphite piston bearings and sealing rings are used in place of oil lubrication in the cylinders. Long rod construction with carbon-graphite piston rod/crank case packing and baffle to guard against oil-creep ensure that the air delivered is free from oil contamination.

Instrumentation for Control

The new Modular ElectroniK control instrument embodies four self contained and easily removable sub-assemblies as a standard feature while the constant voltage unit does away with periodic standardizing and battery replacement. The manufacturers, Honeywell Controls Limited, have also introduced the ElectriK Tel-O-Set miniature system comprising transmitters, recorders, controllers, transducers and final control elements which operates on a two-wire system using d.c. for transmission and some less sophisticated control devices for controlling temperature, pressure, liquid level, and other variables.

Other new Honeywell instruments include differential convertor-transmitters for flow and liquid level, millivoltmeter controllers and many primary sensing elements and data processing equipment.



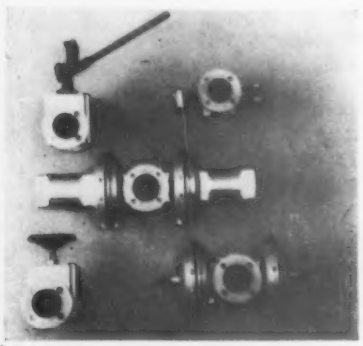
Front view of Honeywell's new miniature electric instrumentation known as the ElectroniK Tel-O-Set system

Pinch Valve Operation

New operational systems for their range of pinch valves to include valves operated by lever, air cylinder and diaphragm motor are announced by W. H. Rowe and Son Limited, Quayside Road, Bitterne Manor, Southampton.

The advantages of the lever operated valve are that it can be made to "fail safe" in the event of a breakdown in the actuating system simply by fitting a weight, and it can be used as a positionally controlled valve by employing an air cylinder with a positional controller as an actuator. Two types of diaphragm operated valve are available depending on whether the horizontally opposed anvils are required to close, to pinch or to open against spring pressure.

With the exception of the air cylinder operated model, all valves are available with bore diameter of 1 in., 2 in. and 3 in. The air-cylinder operated valve is made only in the 2 in. bore but connexion to 1 in. or 3 in. lines can be made by means of tapered adaptors. Hand operated valves are also available with 1½ in. and 4 in. bore.

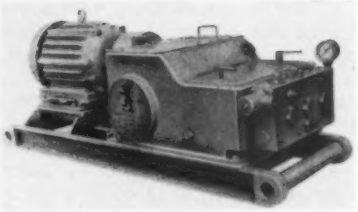


The range of Rowe pinch valves. Top left, lever operated; top right, air cylinder operated; centre, 'Air to open' diaphragm operated; bottom left, hand operated; bottom right, 'Air to close' diaphragm operated

Honeywell's new Ultra-Vision detector for sensing the ultra violet in furnace flames

New Worm Driven Hydraulic Pump

A new worm driven hydraulic pump which has many features likely to appeal to the mining, hydraulic and mechanical engineer, has been introduced by Joseph Evans and Sons (Wolverhampton) limited.

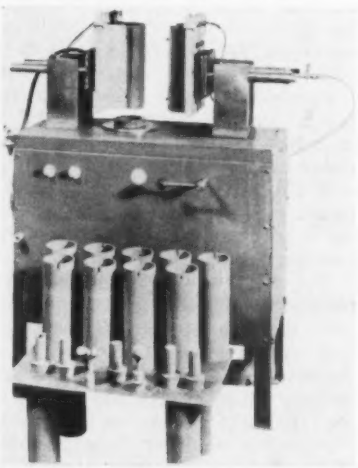


Worm driven hydraulic pump of all steel construction

Known as the 853W/M, it has low plunger speeds and is of compact all steel construction. Designed to occupy a minimum of space its dimensions are : length 5 ft, width 1 ft 10 in., height (ex-motor) 1 ft 8 in. The pump unit is of the 1½ in. × 2 in. horizontal triplex ram type and the duty range, which depends on the speed and horsepower of the motor is from 5 to 7·5 gpm at from 1000 to 1400 psi. The motor, a standard foot-mounted type, is accommodated on a fabricated base plate with skid ends and welded-in tubes for easy handling. Overall weight has been reduced to a minimum. Delivery is ¾ in. B.S.P.T. and suction is 1 in. B.S.P.T., both taken from the end of the pump block.

Shell Core Blower

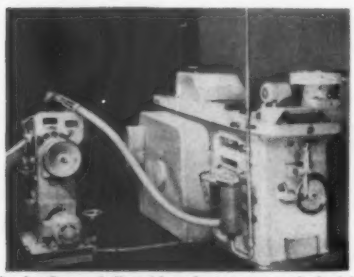
A new machine, the Reynolds shell core blower, for producing shell cores from pre-coated resin sands, capable of performing up to 80 blows an hour has been introduced by the Foundry & Metallurgical Equipment Company Limited, of Weybridge, Surrey. Operation of the machine is extremely simple. After



The Reynolds shell core blower showing a core box opened for removing a shell. Air pressure controls, pressure gauge and control lever are mounted on the front panel. Some specimen cores are shown in front of the machine

closing the core box and raising the sand chamber to seal the core box entry, the cores are blown. The air is then exhausted from the sand chamber, the chamber lowered and the core box opened for removal of the cores. All these operations are completed in the right sequence with a single six-position control lever. A pneumatic vibrator, operated by a push button, empties sand from the cured shells and reduces wastage. An automatic air blower nozzle and hose is fitted for clearing residual sand from working surfaces.

The core blower is enclosed in a floor standing cabinet carrying on the top two machined heads for holding the two halves of the core box. The height of the heads and the gap between them can be adjusted to suit the size of the core box. Mounted on these heads are the heated plates to which the two halves of the core box are attached, the left hand plate being fixed and the other moved by a heavy-duty pneumatic cylinder which opens and closes the core box. Under the bed-plate is mounted a solid drawn steel cylinder sand chamber with a standard capacity of 35 lb, larger chambers being available. The machine has an overall height of 4 ft. The cabinet is 3 ft wide, 1 ft 6 in. deep and 3 ft high. A machine fitted with heated plates 8 in. by 6 in. wide and having a rating of 3 kW is priced at £500. An attachment for handling three-part boxes costs £50.

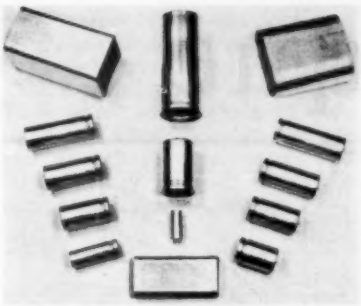


In the Casco shell making plant a pneumatic feed is used between press and automatic rolling and trimming machine

Cans and Containers

The first unit of a cold working plant for the impact extruding of cans, containers, shells and tubes in aluminium, tin, lead or zinc to be marketed under the trade mark "Casco" has been installed at the factory of Casemakers Limited, Soho Hill, Handsworth, Birmingham 19.

The installation consists of a 200 ton horizontal extrusion press which pneumatically feeds a fully automatic rolling and trimming machine.



Examples of cans and tubes made automatically by the Casco plant

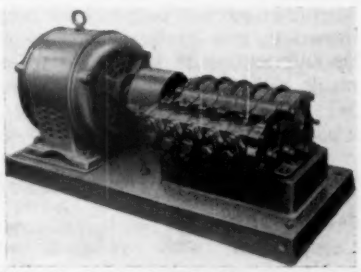
Several machines can be supervised by one operator.

The extruder uses carefully dimensioned pellets or slugs of the appropriate material, for example 99·3—99·8% pure aluminium which are treated with a special lubricant to facilitate impacting. Once the slugs are placed into the sorting drum the process becomes entirely automatic, the slugs being impacted, trimmed and rolled at the rate of 40–70 per minute, dependent upon their size and shape, and circular, square, rectangular, elliptical, or other irregular shapes can be extruded. When the punch enters the die, it strikes the cold slug and forms it to fit the die and then causes it to flow plastically through the annular space between the punch and die. The metal in fact flows up around the punch, the outside diameter of the can thus coinciding with the diameter of the die and the clearance between the punch and the die controlling the wall thickness. The thickness of the base of the can is controlled by adjusting the stroke of the ram.

High Speed Hydraulic Pump

A new development in the design of high speed hydraulic pumps has been introduced by Joseph Evans and Sons (Wolverhampton) Limited, to fulfil the requirements of mining and general engineers who need a high pressure pump of very small capacity.

The pump is of unit construction and with from three to six cylinders, each with an output of 0·6 imperial gallon per minute. A six cylinder unit would have an output of 3·6 gpm. Delivery pressure is 1000 psi. The eccentric shaft which is mounted on roller bearings, is coupled directly to the motor, which runs at a synchronous speed of 1000 rpm, through a flexible coupling. The pumps are suitable for operation with water, water/soluble oil mixture or hydraulic oil as the working medium and with other liquids. The units can be provided with spring loaded relief valves, or with automatic unloading valves.



New series of hydraulic accumulators of screwed end construction

Ultrasonic Cleaning

A new range of ultrasonic cleaning units suitable for cleaning small components such as ball bearing and ball race parts, instrument movements and parts, jewels, watch, clock and chronometer parts, thermionic and hydraulic valve components, germanium and silicon transistor and rectifier components, jewellery in manufacture, optical assemblies including lens frames, lenses, etc., has been introduced by Kerry's (Ultrasonics) Limited, Warton Road, Stratford, London E15.

The units either stand on the bench or fit into a conventional type watch cleaning machine to form part of a normal cleaning sequence including pre-washing, rinsing, drying, etc. There are three standard sizes of round stainless steel containers available, each energized from a 250W peak power generator, operating at a frequency of about 40 kc/s, Type L325, manufactured by Mullard Equipment Limited. The barium titanate transducers are bonded direct to the base of the cleaning container. A number of cleaning containers can be energized consecutively with a selector switch box assembly.

Ultrasonic cleaner for small components together with power unit

technique

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Carpet and Lattice Graphs

It frequently happens that it is desired to plot a set of graphs denoting the use of a series of constants or the introduction of a third variable. Fig. 1a shows an example of engine data curves which is in effect a contour map of the three-dimensional function. It will be appreciated that there are three possible sets of graphs, treating each variable in turn as the contoured item. A great disadvantage of sets of graphs of this nature however is that the individual graphs are so close together in some parts that drawing is difficult and interpolation inaccurate.

Fig. 1b shows a set of graphs, identical to those in Fig. 1a where each successive graph is displaced by an equal amount along the horizontal axis. To facilitate interpolation and avoid repeating the horizontal scale the vertical scale lines are inclined to cross over each graph as shown, the result being a "carpet" graph. These have been widely adopted in recent years for the presentation engineering data.

Actually, the carpet graph is an oblique projection of the three-dimensional surface but may also be regarded as a dimetric projection. It should be noted that the graphs may alternatively be staggered vertically, this being of particular advantage for "round top" curves.

It will be realized that graphs may be staggered both horizontally and vertically but in this case interpolation is made more difficult. These graphs should not be confused with perspective views of three-dimensional surfaces in which interpolation is impossible. To facilitate such interpolation in either case, horizontal contours should be drawn in. Fig. 2 shows an improved form of compound carpet graph. The best method of production is to lay a sheet of tracing paper over an isometric trace chart, draw in the three axes and then plot one set of vertical curves. The other set of vertical curves is then plotted in and finally the horizontal contours. The reference planes and co-ordinate squares finish the chart. The advantage of this chart is not only its aesthetic appeal but also in that equal emphasis is given to each scale and uniform degree of accuracy between each pair.

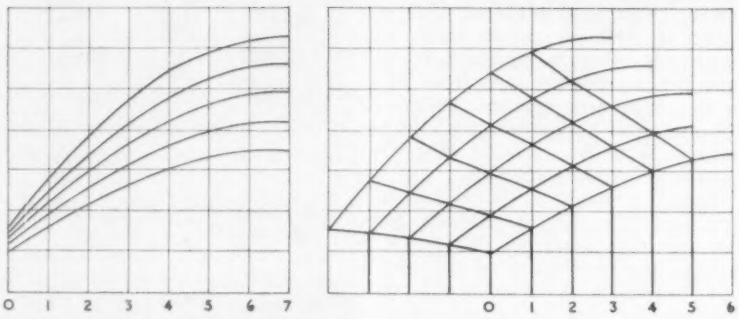


Fig. 1a.—Engine data curves. Fig. 1b (right).—The curves of Fig. 1a displaced horizontally to facilitate interpolation

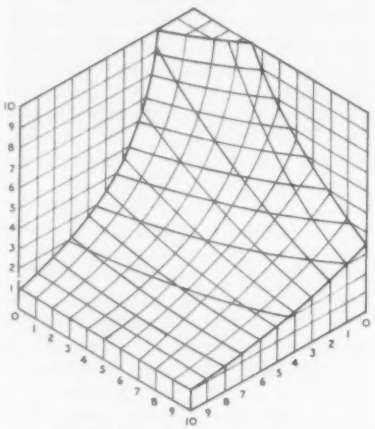


Fig. 2.—Improved form of compound carpet graph

If a series of carpets is drawn for successive values of a fourth dimension, the result is termed a "lattice". Usually it is satisfactory to draw the two end carpets and interpolate by lines joining corresponding points. In more advanced work, two pairs of carpets have been drawn to give particular values at the intersection of joining lines, the result being a lattice nomogram.—**W. H. Sheppard, B.Sc.(Eng.) A.M.I.E.E.**

Protecting Polished Surfaces

Components with polished or machined surfaces are easily damaged and it is often impossible to provide protection for them when handled in large numbers, particularly if they are of an awkward shape. A steering wheel is a good example of a component which is difficult to protect from scratches but British Motor Corporation engineers have overcome the problem by the ingenious use of convoluted rubber hose. As can be seen in the photograph, lengths of convoluted hose are slipped over spindles attached to the side of the stillage at suitable distances. The steering wheels rest snugly between the convolutions which prevent movement and fretting of one wheel against the other. It is a simple matter to feed wheels on to the spindles until they are full and in this manner a large number of wheels can be moved without damage.

Lengths of John Bull convoluted rubber hose slipped over spindles provide a simple means of protecting components with highly finished surfaces

The idea can be adapted for the bulk handling of crankshafts, half-shafts and many other components.

Manufactured by a patent process, convoluted hose is available from the John Bull Rubber Company Limited, Evington Valley Mills, Leicester, in natural or synthetic rubber. It can be obtained in lengths up to four feet with a wall thickness of $\frac{1}{8}$ in. to $\frac{1}{4}$ in. and with internal diameters increasing by $\frac{1}{8}$ in. from $\frac{3}{4}$ in. to 4 in.

The standard pitch of convolutions will be found suitable in most cases but if necessary the pitch can be made to suit the components and the hose may be split lengthwise when stillage design demands.

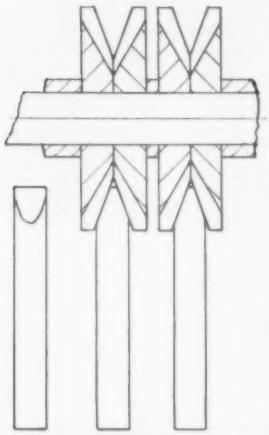


Fig. 1.—Tools for milling screwdriver points

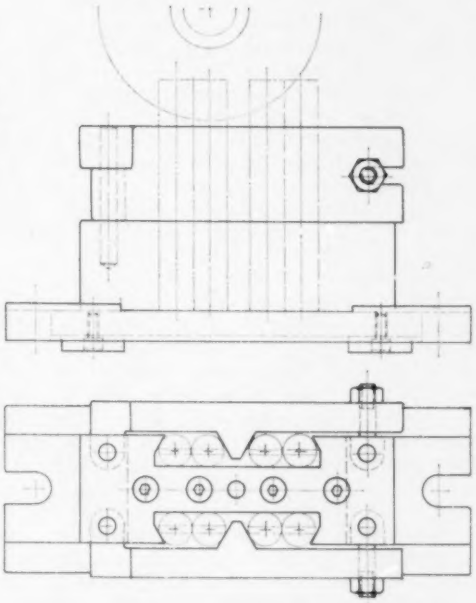


Fig. 2 (right).—Blades for milling set in batches of eight

Tapering Screwdriver Blades

In tapering the ends of special screwdrivers the cut is heavy in relation to the size of the workpiece, both sides being milled simultaneously. To avoid chatter the cutters are staggered to avoid a heavy cyclic load. The accompanying sketch, Fig. 1, illustrates the style of tools and the use of a central collar to match the distances between the sets of cutters with the spacing of the fixture.

Fig. 2 shows blades set in batches of eight with four each side, and held by the wedging action of a clamp. The 60° V-shaped projection pushes each pair of shafts into a 60° dovetail where they are securely locked while being machined.

The locating block is set into a groove machined in the base and tenons underneath match the milling machine table slots. The eight workpieces are lightly tapped down when partly clamped until their ends seat on the baseplate.

A light feed, half that normally employed with cutters of the size and type, and a somewhat higher speed with the staggering mentioned earlier will ensure absence of chatter.

Motor Power for Flywheel Operation

Mechanical presses (and similar machines) make use of flywheel energy as the driving power for the job to give a considerable reduction in the actual motor power required for a specific operation. Where the operation is completed over only a small part of the working cycle, virtually all the energy requirements may be supplied by the flywheel, when the motor size has only to be proportioned to restore the flywheel to speed over the remainder of the cycle. For longer operations, i.e., those taking place over an appreciable part of the work cycle, motor power may be called upon to supplement flywheel energy in order to avoid excessive slowdown or loss of flywheel speed.

For intermittent operation it is generally considered that up to 20% slowdown of the flywheel is acceptable, without calling for excessive motor power to return to speed. At such a maximum slowdown figure, something like 36% of the total flywheel energy is available for producing work. For continuous operation, or where the task is more exacting such as calling for longer strokes and faster working, a maximum of 10% slowdown is generally accepted. At this figure something like 19% of the total flywheel energy is made available.

The actual amount of energy available is readily computed from the inertia formula, the figures quoted above being acceptable for extracting the actual energy available for a nominal slow-down figure corresponding to the maximum available flywheel energy available for intermittent or continuous operation, respectively. Similarly, the energy requirements for a particular job or operation can be calculated on empirical lines, thus relating press capacity to job requirements. Tonnage capacity of a mechanical press, on the other hand, is largely related to the design and strength of the crankshaft—particularly the bending strength of the shaft at the centre of the crankpin and the combined bending and torsional loads in the shaft itself. In general, tonnage capacity can be expressed as equivalent to Cd^2, where d is the shaft diameter and C is a constant varying with the type of shaft and the ratio of the working stroke to the shaft diameter.

As far as power requirements are concerned, where the working conditions and energy requirements are such that the intermittent rating can be assumed, then the flywheel is to all intents and purposes delivering all the energy requirement for the job and the motor has only to return the flywheel to speed. In actual fact the motor will be supplying power over the whole of the cycle and thus supplying some of the energy requirement (i.e., over the working part of the cycle), but this contribution can be regarded as negligible.

Motor horse-power required in such cases can be directly related to job energy requirements (normally computed in inch-ton units) and the number of strokes per minute. In the case of intermittent operation a fair assumption for the number of strokes per minute is the average of the actual maximum number of cycles of operation an operator

would normally be expected to achieve on the particular job and the maximum rated speed of the press.

Fig. 1 has been drawn up to give rapid solutions to motor horse-power required for "intermittent" rating, when the chart has only to be entered at the appropriate energy demand value and motor horse-power required read at the level appropriate to the diagonal corresponding to the number of strokes per minute.

For example, if the job energy requirement is 46 inch-ton and the operating speed of the press seven strokes per minute, the motor horse-power required is read off as 1·5. Energy demand values may be factored, when the horse-power equivalent is multiplied by a similar amount. Thus for an energy demand of 46 × 10 = 460 inch-ton at seven strokes per minute, the original answer would be multiplied by 10, i.e., 1·5 × 10 = 15 hp.

Use of this chart does, of course, assume that the press is suitably proportioned for the job and that the flywheel size and speed is sufficient to yield the job energy demand without exceeding 20% slowdown. Also that the working part of the cycle does not exceed 35°.

Where the requirement is for continuous operation and/or the working part of the cycle is greater than 35° (but not greater than 90°), then Fig. 2 must be used to obtain solutions for motor horse-power required. Here the work demand is expressed in terms of energy deficiency rather than total energy demand, calculated as the difference between the job energy demand and the flywheel energy available (computed at a maximum permissible slowdown, usually 10%). Energy deficiency divided by the actual work cycle in degrees gives the value with which to enter the chart.

Extracting the horse-power figure then follows as before, by relating to the appropriate number of strokes per minute. In this case, however, two horse-power scales are given.

The left-hand horse-power scale refers to the selection of motors which do not or cannot readily accept overloading. Some types of motors, in fact, physically resist slowdown, being limited in this respect to some 5% maximum. Thus if the flywheel slowdown exceeds this figure the motor itself will take on more and more of the power requirement and thus run the risk of becoming seriously overloaded.

With other types of motors, however, a 100% overload may be quite acceptable so that the motor readily shares the energy requirement with the flywheel over the working part of the cycle. Horse-power requirement is correspondingly reduced and may be read off the right-hand scale, particularly as motors of this type which are amenable to slowdown will do so over the working part of the stroke and still let the flywheel provide the bulk of the energy demand.

In the example illustrated in Fig. 2 the data used were: job energy requirement = 118 inch-ton, available flywheel energy at maximum slowdown (computed) = 44 inch-ton, thus energy deficiency = 118-44 = 74 inch-ton.

In this particular case the working cycle accounted for 48° and the number of strokes per minute was 34, hence energy deficiency/degrees work cycle = 1·54.

Entering the chart with this value, the corresponding requirements for motor horse-power are seen to be, for a "stiff" motor, 8·5 hp, and for a motor capable of accepting a 100% overload 4·25 hp.

It should be noted that in this case, since the job requirement is computed on energy deficiency, no limit to the flywheel energy capacity is implied. The greater the energy deficiency, and the longer the work cycle, the higher the motor horse-power demand for a given machine. There is, obviously, an economic limit to motor size beyond which

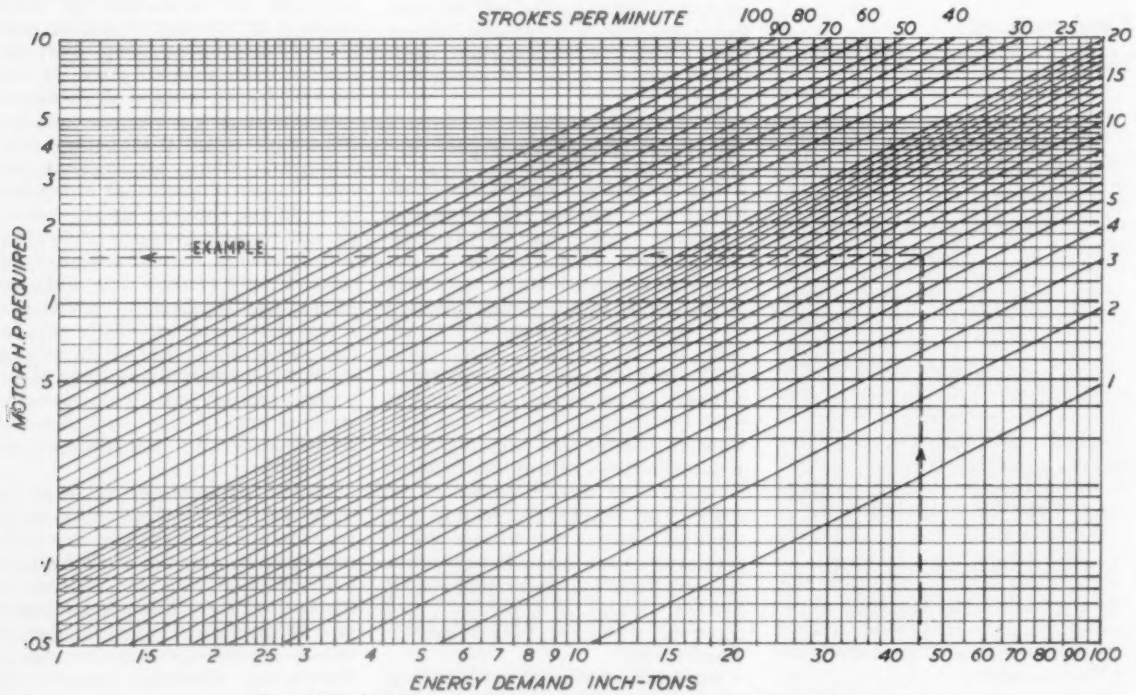


Fig. 1.—Chart for finding motor horse-power (range 0·05–10) required for intermittent rating

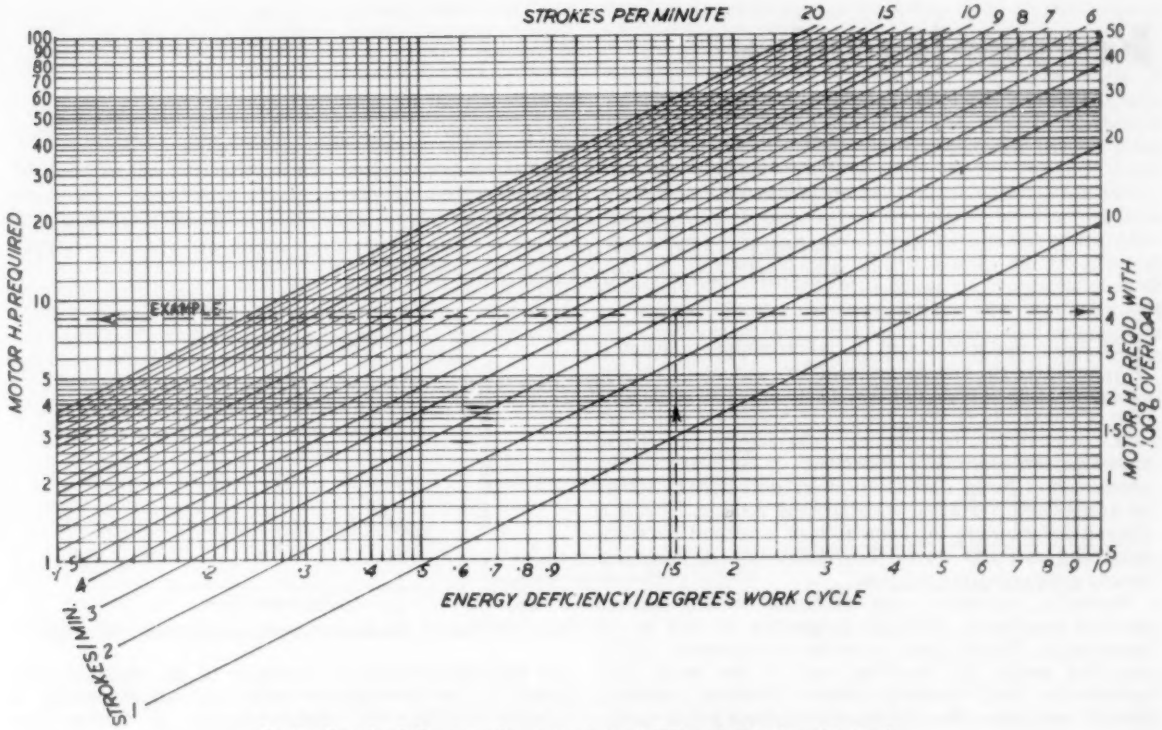


Fig. 2.—Chart for finding motor horse-power (range 1–100) required for intermittent rating

it would be far better to consider increasing the diameter, weight and speed of the flywheel, or going to a geared press.

This situation will normally arise in computing the suitability of a particular press for a given new job. If the flywheel energy alone is not sufficient for the energy requirement of the job, the press is only suitable if the horse-power available is sufficient to handle the energy deficiency divided by the degrees of working cycle involved, as determined from Fig. 2.

As with the first chart, the chart in Fig. 2 can also be factored directly for solutions outside the given scale range. It is not valid, however, for work cycles exceeding 90° although it can be used for solutions involving energy deficiencies and working cycles less than 35°.

S.A.E. Steels

The majority of American steels are of compositions conforming to S.A.E. specifications and employ a numeral index system or coding which is descriptive of the actual composition of the material. The first digit in this number indicates the type of steel and the second digit (generally) the approximate percentage of the main alloying element. The last two digits then indicate the approximate carbon content in hundredths of 1%.

Digit coding (first numeral) is as follows:

carbon steels	1
nickel steels	2
nickel-chromium steels	3
molybdenum steels	4
chromium steels	5
chrome-vanadium steels	6
silicon-manganese steels	9

Typical codings for the first and second digit are then:

plain carbon steels	10
free cutting carbon steels	11
3% nickel steel	23
5% nickel steel	25
1·25% nickel-chrome steel	31
1·75% nickel-chrome steel	32
3·5% nickel-chrome steel	33
carbon-molybdenum steel	40
chrome-molybdenum steel	41
nickel-molybdenum steel (1·75% nickel)	46
nickel-molybdenum steel (3·5% nickel)	48
low chromium steel	51
medium chromium steel	52
1% chrome-vanadium steel	61
2% silicon-manganese steel	92

Example: Identify SAE steel No. 1040. The first two digits, 10, identify a plain carbon steel. The last two digits identify the approximate carbon content, 0·40%.

Example: Identify SAE steel No. 5150. The first two digits, 51, identify a low chromium steel (i.e. nominally 1% chromium). The last two digits identify the approximate carbon content, 0·50%.

It should be noted that the second digit does not invariably identify the approximate alloy composition. In some instances both the second and third digits may be used to identify a specific alloy which could not be properly described under the basic system.

The number may also run to five digits, e.g. where the carbon content cannot be contained in two digits. Thus SAE 52100 specifies a 2% chromium steel with a nominal carbon content of 1%.

SAE numbers agree with A.I.S.I. numbers (American Iron and Steel Institute) although the latter are also designated by a prefix—e.g. C for plain carbon steels and open hearth steels, B for free cutting steels (Bessemer), A for alloy steels, etc. Thus the A.I.S.I. equivalent for SAE No. 1040 in the previous example would be C1040.

Ferroelectrics

Insulating materials which show a variable dielectric constant are characterized as 'ferroelectrics' and may have interesting practical applications. Only a limited range of ferroelectric materials have so far been investigated but these show themselves ideally suited for 'memory' cells, high frequency amplifiers and resonant circuits. Their principle characteristics are described

JUST as a material is said to be ferromagnetic when it is sensitive to, and its permeability can be varied by, a magnetic flux or changing flux, there exists an analagous type of electricity (voltage)-sensitive materials which are said to exhibit ferroelectric characteristics. These materials are essentially dielectrics or 'insulators', the phenomenon being that their dielectric constant shows an appreciable variation with applied voltage. This is a distinct difference to the behaviour of a normal electrical insulating material where the relationship is linear, or closely approximating to linear.

Basically, therefore, any material which exhibits marked non-linear dielectric properties is said to be ferroelectric. Whilst quite a number of materials can be classified under this heading, only a few have been investigated fully—notably barium titanate, titanium dioxide and guanadine aluminium sulphate hexahydrate. These exhibit non-linear dielectric properties to a degree where the phenomenon can be usefully employed.

A characteristic curve showing variation of the dielectric constant with temperature is given in Fig. 1. At first there is a non-linear rise in dielectric constant with increasing temperature, reaching a peak beyond which the value of dielectric constant falls in an opposite manner, but not necessarily a 'mirror image' of the first part of the curve. The transition point, marked by the maximum value of dielectric constant for the material, is called the Curie point or Curie temperature (just as in the case of ferromagnetic materials the Curie point represents a 'transition' temperature—in this case accompanied by loss of ferromagnetic properties). The Curie point of ferroelectric materials may occur at normal room temperatures, or at much higher temperatures, depending both on the material involved and how it is processed.

The temperature-sensitivity of ferroelectric materials is described first since it is this phenomenon which is responsible for the voltage-sensitivity. Non-linearity results from an irregular system of strain set up within

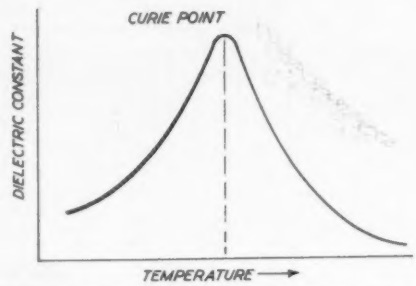


Fig. 1.—Characteristic curve showing variation of dielectric constant with temperature

the individual atoms or domains of the material subjected to an electrostatic field, a condition which is readily modified by slight changes in temperature resulting from changes in the field. Thus a plot of dielectric constant against applied voltage follows a similar pattern to the temperature curve—see Fig. 2—the peak now corresponding to zero applied voltage with a loss of dielectric constant when polarized in either direction.

Another important characteristic is that ferroelectric materials exhibit a characteristic hysteresis effect. This can be plotted in the form of a typical hysteresis loop where the horizontal axis corresponds to the applied voltage (corresponding to the magnetizing force in the case of ferromagnetic materials) and the vertical axis the charge (corresponding to flux). As with ferromagnetic materials the loop is fully closed and exhibits saturation points with both positive and negative polarization—see Fig. 3.

Certain ferroelectric materials exhibit an almost purely rectangular loop, as in Fig. 4, This means that if polarized by saturation in one direction or the other it will remain charged at that level even if subjected to a depolarizing field which can go on decreasing (or increasing) in strength up to nearly the saturation value in the opposite

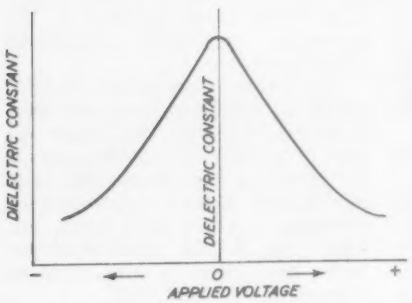
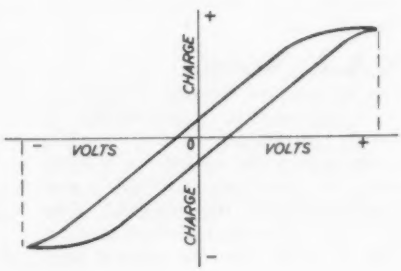


Fig. 2. (left)—The voltage curve is similar to the temperature characteristic

Fig. 3. (right)—Hysteresis characteristic of ferroelectric material exhibits positive and negative saturation points



direction. Once the material has been saturated in a particular direction, in other words, it will remain stable whether or not subjected to further charges in the same direction, or opposite charges of less value than that required to pull the curve off the flat part of the loop.

A particular application of this characteristic is that the ferroelectric material can be used as a 'memory' cell. A thin flat plate cut from a single crystal would normally be employed for this purpose, with a set of parallel conductors bonded to one face and a similar set of parallel conductors bonded to the other face, but running at right angles to the first set—see Fig. 5. This, in effect, forms a grid system with an intervening non-linear dielectric. The dielectric will be 'charged' at any particular point where corresponding grid voltages cross.

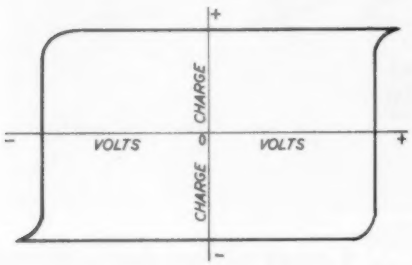


Fig. 4. (left)—Ferroelectric materials having an almost rectangular hysteresis loop remain charged at saturation level.

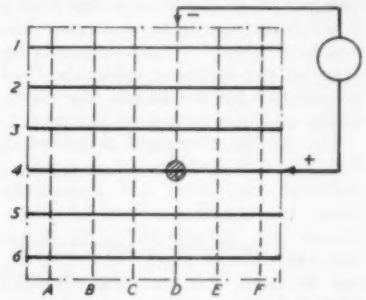


Fig. 5. (right)—The directional effect of a ferroelectric material enables it to be used as a "memory" cell. Two applied voltages result in a "point capacitator"

Thus suppose leads from an external voltage source are fed to line 4 (Fig. 5) on one side of the crystal and line D on the other side. There will be one point only where this voltage crosses to form a point capacitor—shown ringed—and the dielectric will thus become fully charged at this point. Thus a pulse will be recorded and 'remembered' at this particular grid point. Subsequent pulses applied to the same point will have no further effect on this point, nor will pulses applied anywhere else on the grid system. Equally, each individual grid point is a separate 'memory cell', although the dielectric material itself is a homogeneous plate. The grid lines can be extremely closely spaced so that a relatively tiny plate may accommodate some hundreds or thousands of different memory cells—about the only limitation in this respect being the mechanics of producing the conducting elements and rendering them on the surfaces of the dielectric plate.

To extract information from the memory cell it is only necessary to explore the grid with coincident pulses of opposite polarity and opposite strength. These will have the effect of flipping the charge at appropriate points to an exactly opposite polarity, when an output pulse will be obtained. Of course, after the cell has been 'read' once the information is lost and the cell has no further memory of its original polarization. In practice, too, the memory is not necessarily permanent even when stored without reading as there may be an inherent tendency for the charge to decay or the material itself to exhibit characteristics of fatigue and gradually lose its effectiveness as a ferroelectric material. The temperature-sensitivity of ferroelectric materials, previously mentioned, may also have adverse effects, particularly if the Curie point comes within the normal working temperature range of the cell.

To combat these limitations, new materials with more stable ferroelectric properties are being developed.

Various other applications of the non-linear characteristics are possible, following on lines similar to the use of non-linear ferromagnetic properties. Thus a ferroelectric capacitor may be used in amplifier circuits, with the advantage of a very much higher frequency of response than in the case of a ferromagnetic amplifier, also in resonant circuits for triggering and counting applications. It seems fair to assume, in fact, that ferroelectrics will come very much to the fore within the next few years although it is still generally regarded as of laboratory rather than applied interest.

Direct Reading Oscilloscope

The new type 425 oscilloscope, manufactured by The Allen B. Du Mont Laboratories of New Jersey, which incorporates the first direct digital reading system in an oscilloscope, is available in Britain from Leland Instruments Limited, Abbey House, Victoria Street, London SW1. This high frequency instrument for use from d.c. to 60 megacycles (down 3 DB at 35 mc), is designed round a new tube which operates with 12,000 volt acceleration potential giving an extremely high sensitivity, high light output and high resolution on its 10 cm × 5 cm display area.

The instrument is built on the modular constructional system in five easily replaceable units and a variety of plug-in modular units is available. Among its features is the numerical read-out system giving increased accuracy because the possible errors of interpolating and converting mathematically have been eliminated, and making it possible for unskilled personnel to use oscilloscopes in production control processes. After the original setting-up of the instrument by an engineer the operator can read the amplitude and time measurements as actual digits on the face of the oscilloscope. In addition, the instrument may be connected directly to punched-card equipment for recording and analysis. Power requirements are 1,000 W at 60 cps, 115 volt. It is also available for 48 to 450 cycle power sources.

Type 425 oscilloscope

Rotary Transfer Machine

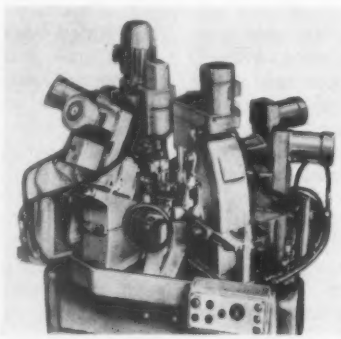
The Schaublin-20 rotary transfer machine is intended for batch production and would be suitable for a plant producing sufficient quantities to occupy a multi-spindle automatic for a week.

The machine consists of a central pedestal inside which is an indexing work-carrying table with a number of stations either fixed or revolving, and around the pedestal are fixed a number of motor driven machining heads to a maximum of eleven. The machine also incorporates driving gear for the indexing table, the feed mechanism for the heads, the cross-slides, and other essential equipment.

The surface machined is limited to 4 in. × 4 in. centres in any place, although this does not necessarily mean the maximum size of piece. Power per spindle is 1½ hp (Continental). Drills down to 0·010 in. can be used, the maximum drilling or tapping capacity being ⅜ in. in steel and ⅝ in. in aluminium. The drilling of larger diameter holes can be effected if the operation is spread over several stations.

The Schaublin-20 has been used in factories producing such pieces as fountain pen components, small electric motors, fuel pumps, pipe fittings, car accessories, ordnance work, etc. The manufacturers are Schaublin S.A., of Bevilard, and it is distributed in this country by Wickman Limited, Coventry.

Below, the Schaublin rotary transfer machine. Above, pieces machined on the Schaublin



Vertical Turret Lathe

The KE 12 vertical turret lathe with table size 49 in., has centralized remote control (all electric) enabling table speed to be changed even while cutting. By increasing table feeds step by step during facing it is possible to give a reasonably constant table speed irrespective of diameter. A device can be supplied which will do this automatically. Any tool can be put into position and stopping, starting and inching of the table can be controlled by push button on the pendant. Forced feed lubrication is provided.

The main drive gear box with hardened and ground gears is inserted into the column from the back and effectively sealed. It can be readily removed for servicing if necessary. The cross rail, like the column, is of heavily ribbed section and is of box form. A separate motor is provided for vertical and cross adjustment. The two heads (cross rail and side arm) are operated each in the same way but independently of each other and both have twelve feeds which can be preselected. The turret can be unlocked, indexed and reclamped by a single operating lever. Profiling tracer control, electrically operated via the electro magnetic clutches, is provided to enable repeated production of similar shapes. Automatic tripping devices can also be provided to ensure the maintenance of given dimensions on lot production, diameters and turning lengths being both covered.

Charles Churchill & Co. Limited, Coventry Road, South Yardley, Birmingham, are British agents for the KE 12 lathe which is manufactured by Froriep Limited, Rheydt, Western Germany.

Centreless Grinding

Designed and manufactured by Arthur Scrivener Limited, and sold throughout the world by Wickman Limited, Fletchamstead Highway, Coventry, the new Wickman-Scrivener No. 1 centreless grinding machine has built-in steplessly variable power-truing as standard on both wheels; an exceptional range of control wheel speeds steplessly variable from 10 to 750 rpm, with the ability to tilt the control wheel up to 7° in either direction for orthodox or back-feeding; universal workrest suitable for both through-feed and plunge-feed workplates with either workplate packing strips or eccentric-roll workplate lifter for rapid height adjustment (extra-cost feature); and a swivelling control-head slide for the rapid correction of tapered work. The workrest is mounted on the control head slide and can be instantly coupled to it or retained fixed (relative to the grinding wheel head) at will, thereby much facilitating workrest adjustment to follow up grinding wheel wear.

Especial attention has been paid, in developing this new machine, to ease of set-up, rapidity of change-over and versatility of operation, and as with all Wickman-Scrivener machines, controlled-cycle auto-infeed equipment can be subsequently added to convert hand-operated versions to semi-automatic operation. Controlled-cycle equipment consists

of two principal parts—an auto-infeed camslide unit attached to the swivel slide of the machine, and a separate self-contained power-unit console. Other optionally available extras on the standard machine are a pneumatic auto work-ejector, coolant-through-the-wheel equipment and low-voltage machine lighting.

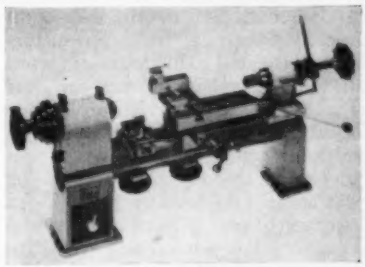
Advanced features which can be incorporated in the new model if ordered as original equipment include automatic dressing of either the grinding wheel or the control wheel, or automatic programme dressing of both, and oscillating or axially adjustable spindle arrangements. Together with controlled-cycle auto-infeed equipment arranged in synchronism with an automatic parts feeder or loader, and with automatic size control, machines equipped with automatic programme dressing of both wheels are not merely automatic in operation, but can function for extended periods entirely without operator intervention.

Toolmakers' Lathe

The Ime universal precision instrument and toolmakers' lathe is a new product incorporating a number of interesting features. Made of tool steel, precision ground and hand scraped, it is firmly secured to two cast iron bases to allow working without vibration.

The solid steel headstock, with reversing switch, is provided with a clamp to achieve a firm grip on the bed by the slightest touch of the handle. The spindle, with maximum bore of approximately $\frac{1}{2}$ in. is of nickel chromium steel and runs in conical bearings, and a special nut allows adjustment. The American-type collets with external threads, to be drawn in by either draw-in-bars with plastic knob or by collet closer, allow opening and closing whilst the machine is in motion. Lubrication is through two large grease-loaded grease caps, dust covers are provided for front and rear bearings and two oil-retaining felt washers safeguard the bearings from within. The 3-speed pulley is of steel, and on the outside and at the largest diameter sixty holes for dividing purposes are provided, to which an indexing arrangement with spring-loaded pin is affixed.

The tailstock is of cast iron and standard equipment is with sleeve to



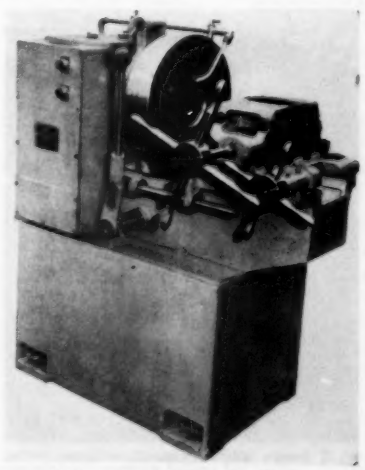
Ime universal precision instrument and toolmakers lathe

take the same type of collet as for the headstock, and lever attachment for drilling purposes. A graduated bar (engraved to $\frac{1}{25}$ in.), adjustable, is incorporated to set up the depth of drilling. The makers, Ideal Machine Tool and Engineering Company Limited, have available and in preparation a large number of accessories and attachments.

6-in. Screwing Machine

A 6-in. universal screwing machine, type U.R., is now being made by Joshua Heap & Co. Limited, Ashton-under-Lyne, in addition to the 4-in. machine, previously the maximum capacity for this type. Both machines are similarly mounted on cast iron cabinets, which form suds tanks and troughs for the cutting swarf.

The 6-in. machine is fitted with cam type radial die head which can be opened and closed by a bow fork and lever whilst the machine is running; the saddle is mounted on square slideways. The 4-in. machine has a tangential die head which can be fitted with dieholders and dies for



6-in. universal screwing machine

screwing taper and parallel pipes and bolts. Vices of the open jaw self-centring type are used on both machines and vice jaws are supplied in sets of two for diameters up to 1 in. and in sets of four for the larger sizes. The motors are flange mounted and directly coupled to the driving shaft through a flexible coupling. Four spindle speeds are available, obtained by means of change wheels made from medium carbon steel forgings running in an oil bath. The final drives to the main spindles are through case hardened and ground nickle steel worms and centrifugally cast phopshor bronze worm wheels. The first driving shafts and worm shafts are mounted on ball bearings. The machines are complete with electric suds pumps and all the necessary piping, valves, splash guards, etc.

Universal Gear Hobber

A 24 in. universal gear hobber which will accept a maximum gear diameter of 26 in. and an alternative machine to accept gears up to 36 in. dia have been developed by Churchill Gear Machines Limited, 1323 Coventry Road, South Yardley, Birmingham.

The vertical traverse on the hob slide is 15 in. the maximum diametral pitch is 3, the minimum number of teeth which can be cut is 8, the machine will accept hobs 7 in. maximum diameter, and 7 in. maximum length. The main drive motor is 10 hp, the net weight of the machine is $7\frac{1}{2}$ ton, and the dimensions—length, width and height respectively, are—9 ft, 5 ft and 7 ft 2 in. Dual lead worm gearing systems are utilized on the hob spindle drive and index table drive. The index worm on the 24 in. machine is 17 in. dia and has 72 teeth of $\frac{3}{4}$ in. pitch. The machine is equipped with infinitely variable feed and speed mechanisms, controlled through P.I.V. units, to give speeds between 65 and 300 rpm, and vertical feed rates between 0·010 in. and 0·29 in.

An arrangement for automatic feed change at full depth is also provided, the change gear being electro-magnetically operated through clutches of the oil immersed type. The hob head can be arranged through a selector switch, again automatically controlled through an

electro-magnetic clutch to give axial tangential or diagonal feed. The machine can also be arranged for intermittent hob shift which is timer controlled to give 0·005 in. per sec between components.

The tailstock is of robust construction and hydraulically operated. Hydraulic clamping to the vertical slide, which carries the hob head, is provided for tangential or infeed hobbing. For climb or normal hobbing, an automatically compensated hydraulic balance arrangement is brought into operation on the hob head, and hob head slides, the dead weight of which is 16 cwt to assist the thrust in the direction of cut. The over arm support, having been pre-set, dependent on the range of work being processed, is automatically clamped when the hob has reached full depth and commenced to vertical feed, thus ensuring rigidity, and to facilitate awkward lifts on heavy components the over arm can be completely removed. The infeed motion is controlled at full depth through a micro screw arrangement on to a dead stop. The differential mechanism has been designed to give a constant of 1 and provision has also been made to cut gears having prime numbers of teeth and, provided that the prime number is less than 200, standard gear trains can be utilized. Prime numbers over 200 would require special gears. Light indicators are provided for all feed motions which will signal to the operator that the micro switch for each particular movement has been made to facilitate set-up procedure.

General Purpose Boring Machine

The No. 2 Kearns patent horizontal surfacing, boring, milling, drilling and tapping machine with Microptic setting to all movements is made in a range of workholding capacities and is capable of widest application and all classes of work. The outstanding feature is the combination of a nitrided superfinished travelling spindle with a built-in automatic facing chuck. The facing chuck feed mechanism incorporates recent patents and is of the simplest character. Constructed on the unit principle, the machine is unusually massive and capable of dealing with continuous heavy loads.

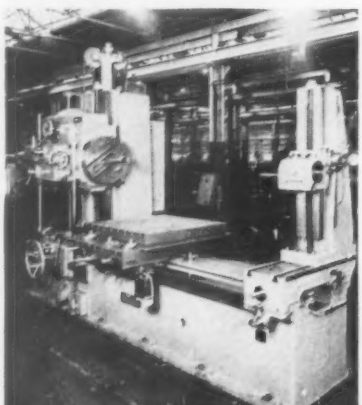
The design of the spindle and facing chuck sleeve bearings has received very careful attention. In the case of the spindle, the forward end is supported in a bush carried on precision anti-friction bearings. In all there are eight anti-friction bearings supporting this spindle throughout its length. For the facing chuck sleeve, two large diameter phosphor bronze bearings are used. These are arranged to give support to the facing chuck, almost to the point of the facing slide.

Lubrication on this machine is comprehensive and in the case of the spindle slide, consists of a built-in automatic system. Oil from a steel sump under the slide is circulated throughout the headstock from a plunger pump inside the spindle slide. A separate compartment in the sump contains the special oil for the sliding ways of the column.

To meet the need for a simple and easy method of co-ordinate setting, the Microptic scale reader has been designed in conjunction with Hilger & Watts Limited. It is used with special stainless steel scales produced by James Chesterman & Co. Limited, Sheffield.

An important feature is the provision of the coarse and fine readings within one field of view. As the unit is mounted on a small adjustable bracket datum settings are easily made.

To avoid having the optical lamps being switched on continuously, the arrangement is provided with a pneumatic time switch which can be easily adjusted to suit the operating conditions.—H. W. Kearns & Co. Limited, Broadheath, Nr. Manchester.



No. 2 Kearns patent horizontal surfacing, boring, milling, drilling, and tapping machine with Microptic setting to all movements

Vertical Spindle Lathe

One of the special features of the Vertinax production lathe made by Charles Churchill & Co. Limited, Coventry Road, South Yardley, Birmingham, is the vertical position of the chucking spindle, which saves floor space and allows easy loading. The spindle, which has a large diameter flange, is fitted with a wedge action air operated chuck.

The machine carries two hydraulically operated tool slides which can be swivelled from below the horizonal to beyond the vertical position to allow the machining of two internal tapers, two external tapers, or one internal and external taper as well as normal turning operations. Pulsation can be imparted to the slides so that efficient chip breaking is obtained under any operating conditions. The slides are fully automatic and hand operation is also possible; they are easily adjusted and calibrated dials permit easy repetition.

Conveniently positioned push button controls operate all machine movements and individual levers are provided for clutch operation, spindle brake and tool slide movements. An ammeter for the main drive motor allows maximum horse-power to be utilized for each job. Also available is a profile turning attachment.

Although mainly intended for repetition work the machine can be used for small batches. It is made in three sizes, 2, 3 and 3a.

Peterman Automatics

An example of the kind of work done on the Peterman P7 automatic is tooling to produce a brass ball point pen component. The machine is of the new cabinet base type and is fitted with electronic variator to control the camshaft drive. Infinitely variable camshaft speeds of the whole range can be obtained. The headstock is operated by bell cam.

The machine carries five tools and has micro-differential micrometers on all tool positions, carbide toes and tips and other refinements. A combined centring, drilling and screwing attachment is furnished. The headstock spindle runs in Nadella needle roller bearings and a patented device ensures that equal pressures are exerted on the collet through balanced toggles. A safety

device is provided to stop the camshaft instantly in the case of overload, etc. The operations involved are centring, drilling two diameters, turning and cutting off, and give an indication of the versatility of this automatic which is capable of the very highest production.

Another Peterman automatic, the P16, has a capacity for bars up to ⅝ in. dia and in one example is tooled to produce a workpiece, the production of which involves the following operations: centring, drilling three diameters—smallest right through the component, tapping, and externally threading two diameters one left hand one right hand; these operations are taken care of by the turret. There are three further operations; headstock spindle stopping and indexing for cross drilling two separate holes, roll marking, and turning, parting off, etc.

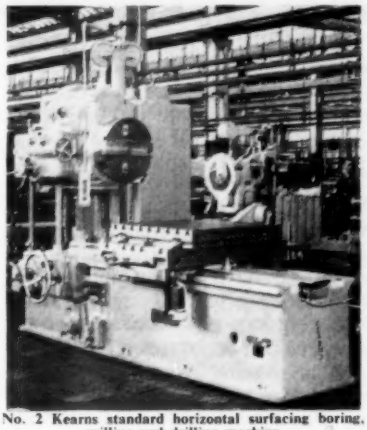
As well as being furnished with six toolholders this machine is provided with a six station turret. The headstock spindle is mounted in antifriction bearings, a double race roller bearing being fitted at the front and contact type bearings at the rear. The endless belt which drives the spindle can easily be changed without any dismantling. A patented device ensures that the pressure of the chuck toggles is equalized. An accelerator is fitted which gives a second (accelerated) speed to the camshaft of 8 rpm and this is used during idle time to increase production rates.

The agents in this country for Peterman machines are Charles Churchill & Co. Limited, Coventry Road, South Yardley, Birmingham.

Heavy Surfacing

Based on over fifty years' experience in producing horizontal surfacing and boring machines, the No. 2 Kearns standard horizontal surfacing boring, milling and drilling machine is primarily designed for dealing with heavy surfacing operations. Constructed from units it is available in a wide range of capacities. Particularly important on this type of machine is the need for a smooth and steady drive to the massive headstock. The Kearns cushioned arrangement not only reduces shock load to the driving mechanism, particularly on heavy intermittent surfacing operations, but acts as a safety device and avoids serious damage to the driving mechanism if an accident should occur.

The heavy duty built-in automatic



No. 2 Kearns standard horizontal surfacing boring, milling and drilling machine

facing chuck is carried on a long and large diameter spindle supported in three massive phosphor bronze bearings. The eight-change gear box in conjunction with four changes of speed on the spindle gives a total of 32 speeds to the facing chuck.

Automatic lubrication is provided to all the principal units on the machine, including a comprehensive system to the spindle slide and facing chuck mechanism.

The machine is particularly suitable for dealing with valves and similar components where facing operations predominate. The combination of a wide range of speeds and feeds, together with the built-in revolving table enables a comprehensive range of machining operations to be completed, often at one setting of the component.

The machine is available with a screwcutting arrangement which is invaluable for dealing with screwed seatings in valves.

The facing slide is arranged with two T-slots along its full length. This enables two facing tools to be used and thus reduce the roughing operation on a flange to half the time required by a single tool.—H. W. Kearns & Co. Limited, Broadheath, Nr. Manchester.

Churchill Lathes

A well-known name in the field of lathe manufacture is Churchill Redman Limited, of Halifax. The 22 SL is one of their standard duty lathes having a 22 in. swing and arranged for sliding, surfacing and screwcutting. Its noteworthy features include hydraulically operated headstock clutch and brake, totally enclosed gearbox giving thirty threads and feeds, hardened steel bedways for saddle power, rapid traverse to saddle and cross slide operated from apron, etc.

Another of this company's products, the 15 ML lathe, is a quality precision centre lathe into which have been built features such as the mounting of the main spindle in Gamet precision taper roller bearings; hobbed, shaved and induction hardened gears, totally enclosed dial operated gearbox giving forty threads and feeds, etc. This machine can also be furnished with profiling equipment.

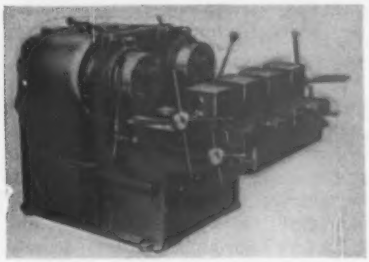
The Churchill 28 L lathe is of the heavy duty type incorporating features which make for close accuracy and high metal removal over long periods. Such features are embodied as the mounting of the main spindle in a Timken taper roller assembly at the front and parallel rollers at the centre and rear, ensuring a very sturdy spindle mounting. The spindle nose is of the long taper key drive type. A hydraulically operated clutch makes practically finger tip control and a smooth take up drive. All intermediate shafts are splined and run in ball or roller bearings and gears hobbed, shaved and hardened. Dynamic balancing ensures freedom from vibration.

All three lathes can be furnished with profiling equipment.

Screwing Machines

The 2-in. twin head tangential screwing machine made by Joshua Heap & Co. Limited, Ashton-under-Lyne, has been re-designed to bring it into line with specifications for single head machines. The speed range has been increased and the main spindle mounted on taper and parallel roller bearings. As in the 1-in. single head machine, in addition to the hand releasing motion worked by lever, the dies open automatically when any predetermined length has been screwed and close on return of the carriage. An automatic pump for cutting lubricant with the necessary piping, valves, splash guards, etc. is supplied for both machines.

The drive is taken from the motor to the gear box through V-ropes and in the twin head machine V-ropes take the drive from the four speed, gear driven spindle to the two speed spindle. A reversing mechanism can be fitted to the right-hand spindle so that left-hand threads can be cut



2-in. twin head tangential screwing machine

whilst the other head is cutting right-hand threads.

The makers also supply a 4-in. tangential single head machine, similar in design. This has, in addition, a roughing and finishing device to enable threads over 1½ in. to be cut at two passes.

Gear Shaving

An entirely new range of gear shaving machines, with operational features especially developed to improve reliability, repetitive accuracy, set-up facility and accessibility has been introduced by Churchill Gear Machines Limited, 1323 Coventry Road, South Yardley, Birmingham.

The S.A.U. 8 in. is a semi-automatic universal machine, equipped with new micro positive auto-electric knee and table operations, and hydraulically operated automatic tailstock. The operator has simply to place the component on its arbor, in mesh with the gear shaving cutter, and on an approximate locator, before closing the guard door and operating the machine cycle start button. The automatic tailstock will then come forward to locate the component between centres and the shaving cycle will commence.

The other machine, the model F.A.U. 8 in. In-Line, also incorporates the micro positive auto-electric knee and table, and automatic hydraulic tailstock unit. In addition a standard C.G.M. auto-loader and conveyor system is utilized. The auto-loader incorporates a hydraulic piston arrangement to transfer the components from the pick-up to the cutting and ejection points between the load and to the unload conveyors. The conveyors are of the electric motor driven rapid indexing type, and are arranged with an electrical signalling system to ensure that a component is always available at the pick-up point, even though the conveyor might be partially empty.

Gear Tooth Chamfering

The G.R.C. 8 in. gear tooth chamfering machine is designed to facilitate automatic loading, and to accommodate single, compound, or cluster gears. Made by Churchill Gear Machines Limited, 1323 Coventry Road, South Yardley, Birmingham, the machine is built on a unit construction principle, the column, knee, table cutter head and slide, being separate units. By changing cutter heads and special tooling equipment, gear tooth rounding can be carried out or the machine can be arranged for keyway milling, honing or drilling.

For chamfering, semi-automatic head and tailstocks would normally be used, the gear being mounted between centres. For loading and unloading the component is loaded on its arbor, placed in the machine in mesh with the cutter, and on an approximate locator. The chamfering tool is in the form of two discs situated at each end of the component, and cut to the transverse characteristics of the gear being processed. These plates are impinged on the end faces of the component by applying pneumatic pressure alternately to cylinders at each end of the cutter head. A centralizing air cylinder is also provided. When chamfering it is also necessary to provide side frazing tools to remove the slight burr thrown up by the chamfering operation.

The rounding operation is performed by using a high speed straight shanked pencil type cutter. The workpiece is automatically rotated and indexed through an all geared headstock, and axially reciprocated by means of an interchangeable cam fitted to the workhead, with the follower attached through a lever to the machine table. The cutter head spindle runs in precision taper roller bearings and has a 3 in. vertical micro adjustment to the quill. The cutting tool is held by a draw rod collet chuck, and the drive is by V-ropes mounted on four special pulleys. The workhead spindle runs in precision roller bearings in the front and a parallel roller bearing at the rear. The drive is from a directly coupled flange mounted motor through two sets of change wheels and for range work it is merely necessary to change one gear, dependent upon the number of teeth to be cut. On the top of the workhead a fixed centre distance gear train is situated, and with alternate pairs of gears the number of teeth cut per minute can be selected. The workhead incorporates, as a standard unit, a pneumatically operated draw rod attachment, and the tooling adaptors will be fitted to the actual workhead spindle face.

Precision Milling and Boring

The latest development in the Scharmann range of precision milling and boring machines is the FB 500B Opticut, designed primarily for precision boring, snout boring, heavy milling and general diameter facing and incorporating a number of special features. It can be arranged with electro-mechanical programme or tape control and can also be arranged for digital control.

One of the particular features of the machine is that the boring and milling head is carried on two columns and the spindle always operates on the centre line. The saddle is carried on three hardened bedways, approximately 4 ft wide, thus imparting great accuracy to the machine. The whole of the construction of the column and bed incorporates heavy ribbing which gives maximum rigidity.

A massive rotary table is provided and outboard saddle supports can be furnished. The tailstock of the machine provides concentric support for the boring block. Full directional control is available from the pendant and an automatic tool ejector is provided which is push button controlled. Direct optical reading equipment and also an optical indexing arrangement can be furnished, and an independent facing head and automatic positioning are available. Fully automatic lubrication is provided and refinements such as hardened steel strips for the ways and phosphor bronze inserts on the mating surfaces are incorporated.

Two other Scharmann machines in this range are the FB 300 and the FB 315 with 3 in. and 3½ in. dia spindles respectively. All three machines have a variable range of spindle speeds and boring and milling feeds. Extra equipment is also available.

Scharmann machines are distributed in this country by Charles Churchill & Co. Limited, Coventry Road, South Yardley, Birmingham.

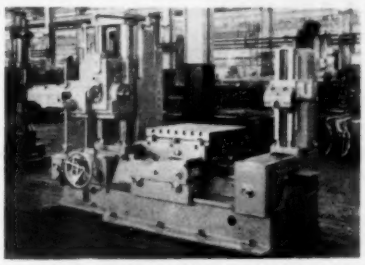
Optimetric Tool-room Boring Machine

The present Kearns Optimetric horizontal tool-room boring machine model 450B, with optical depth control to the main spindle, incorporates many new features. It has been developed to meet the demand for a modern accurate high speed tool room machine and is equally suitable for a wide range of general work, in single pieces or quantities. Constructed on the Kearns unit system its capacity can be modified considerably to suit requirements. Long life and accuracy are ensured by the lubrication systems in the unit gear boxes and on the sliding ways throughout the machine. To assist in damping vibrations and to ensure a high degree of finish on the component, a cushioned belt drive is provided between the main motor and gear box and another between that unit and the spindle slide.

A channel in the bed directly under the centre line of the travelling spindle constitutes both the longitudinal guide and the primary load bearing surface for the saddle. The ends of the saddle carry large diameter rollers which rotate on anti-friction bearings and are supported by the outer ways. The compound table consists of the saddle, main table and cellular-constructed revolving table. Rotation of the revolving table is assisted by a built-in lifting motion housed in the main table. Accurate location of the revolving table in four positions is provided by hardened and ground inserts in engagement with a hardened steel catch. The oil tank and pump for lubricating the table ways are incorporated in the saddle.

A patented feed motion applies to all traverses. There are two feed ranges with six feeds in each. Combination of a high spindle speed and slow feed gives a fine feed per revolution for fine boring. A simple system of pick-off gears, or worm and worm wheels enables either or both feed ranges to be modified.

The nitrided travelling spindle is superfinished and slides through the sleeve in which a special nitrided cast iron bush is used. The spindle slide, which is balanced by a weight hanging inside the column, is arranged with narrow guides and the spindle sleeve is mounted close to



Kearns Optimetric horizontal toolroom boring machine model 450B, with optical depth control to the main spindle

the column face on special precision ball and roller bearings.

Flush mounted, gate type, controls are very conveniently grouped.

Electrical equipment includes a 5 hp main motor and one of 1 hp for the independent rapid traverse. Both are direct-on started and braked by employing d.c. injection. The switchgear is housed in a dust proof sheet steel case fitted at the rear of the column. The main driving motor is totally enclosed and built to the latest British Standard. It drives a nine-speed gear box which, in conjunction with a gear arrangement on the spindle slide, gives a total of 18 speeds to the spindle ranging from 20 to 1,000 rpm.

The patented Optimetric system is fitted to the vertical adjustment of the spindle slide and boring stay bearing and transverse movement of the main table, and also to the spindle tail bracket. Operation of all the optical units is through a conveniently placed pneumatic time switch.

The machine is complete with a simple pendant control system for operating the main motor.—H. W. Kearns & Co. Limited, Broadheath, Nr. Manchester.

Gear Honing

A machine to apply the principle of finish honing gears to remove nicks and burrs, and improve surface finish quality is being made by Churchill Gear Machines Limited, 1323 Coventry Road, South Yardley, Birmingham. It is arranged with the cutter heat at the rear of the work to facilitate hand loading, and reduce operating height. The cutter head is mounted on a cylindrical slide and thus can be moved forward as a unit for coarse adjustment. Final adjustment and the application of the honing pressure is obtained through an additional pressure controlled movement over a short distance.

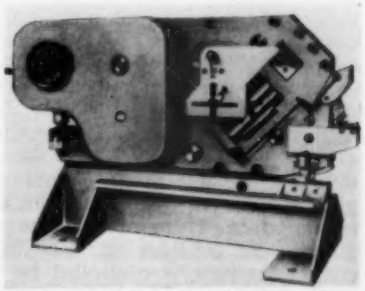
The knee of the machine, of very simple construction is fitted with a conventional table and compound change gears as used on a conventional gear shaver.

The table drive motor is 0·86 hp, 890 rpm of Demag design with a built-in brake. For the honing operation the table ends its cycle in the centre position so that when honing pressure is applied there is full face width contact between hone and gear. Table stroke trips are fitted on a disc mounted in the knee, and the over-travel trips are integral with the stroke trip to prevent any possibility of overrun through incorrect trip setting.

The drive to the hone is through a 1 hp 750 rpm motor, with a take-up clutch attached to the motor shaft to soften up reversal. The drive from the motor to the cutter head is through a 3 step pulley and V-belt to give speeds of approximately—200, 280 and 350 rpm. The electrical controls are arranged in a compartment on the left-hand side of the machine, and hydraulic controls in a panel on the right, and change gears at the rear of the machine. The coolant return has been so arranged that, if desired, a clarifier can readily be incorporated in the system.

Punching and Shearing

The Mafrino bar cutting and punching machine will deal with special sections as well as the usual bars, and will cut mitres at any angle up to 45°, and the cutter housing is automatically adjusted to the size of the work thus ensuring clean cutting. The machine will cut plate up to $\frac{1}{2}$ in. and flat bar in one stroke up to 4 in. × $\frac{11}{16}$ in., angle and T-iron up to 4 in. × $\frac{1}{2}$ in., rounds up to $1\frac{1}{2}$ in., squares up to $1\frac{3}{16}$ in., channel and joists $\frac{3}{8}$ in. thickness, holes up to $\frac{13}{16}$ in. dia × $\frac{9}{16}$ in. deep.—William Watts Limited, Canal Street, Nottingham.



Mafrino punching, shearing and notching machine

Diffusion Coatings

A diffused coating is alloyed to the parent metal and the integral nature of the bond gives valuable mechanical properties. The surface change is essentially physical being largely by exchange of atoms. High temperatures are usually necessary for the process. The coating may have been deposited previously by some other method or be applied directly in vapour form or as a contact pack

DIFFUSED surface coatings, as opposed to additive coatings, imply that the surface coating is keyed to the parent metal by other than a mechanical bond. Paint coatings, metal sprayed surfaces, electro-deposited films are all additive coatings in that they are applied essentially as a mechanical layer and keying, if present, is of an adhesive or mechanical nature. A diffused coating, on the other hand, forms an alloy at the surface of the parent metal. The resulting thickness of surface coating may be all alloy, or with the outer surface consisting of the diffusing element spreading into an alloy interface joining to the parent metal. Specific methods are employed for producing diffusion surfaces but the same action may be present in conventional techniques. Hot-dip galvanizing, for example, produces an outer layer of pure zinc with an interface of zinc-iron alloy on the surface of the parent iron.

Because of the integral nature of the bond, diffused surface coatings are generally superior in performance to additive coatings. Thus their behaviour is particularly attractive as protective coatings whilst at the same time the enhanced physical properties possible may be put to mechanical advantage, as in the case of chrome-diffused aluminium. In other cases, too, the ductility of diffusion coatings is comparable with that of the parent metal so that it is not disrupted by subsequent mechanical deformation.

Although the process of diffusion coating may be initiated by chemical reaction, but not invariably so, the resulting surface change is essentially of a physical nature in that a solid solution is formed at the surface. The parent metal acts as the solvent and the diffusing element the solute with an exchange of atoms or ions. Essentially, the solvent metal must remain solid throughout but the solute may be rendered at the surface as a gas, liquid or solid, the rate of diffusion generally decreasing in that order. The actual mechanics of the diffusion system involved depends very much on the nature of the solvent and solute, and in particular the size of their atoms. Gas diffusion into metal may be largely accomplished on the basis of inclusion, but metal-to-metal diffusion is more largely by substitution since in this case the atoms are generally of similar size and the solute cannot be accommodated readily in the lattice of the solvent.

This is in keeping with the fact that high temperatures are normally necessary to promote metal-into-metal diffusion, an increase in temperature being necessary to give enough energy for the metallic atoms to be displaced in the lattice. The processing temperature thus largely governs the diffusion rate—see Fig. 1. The depth of coating, in turn, is controlled by the solubility of the coating element which, in turn, governs the concentration of the solute element which can be employed.

A method of promoting metal-into-metal diffusion is to coat the parent metal with a layer of the diffusing element as a deposited coating, e.g. by electroplating or metal spraying and then subject the combination to heat treatment to promote alloying of the two metals at the interface. The outer surface remains unchanged as the diffusion element, merging into a transition zone of alloy and thence the parent metal, providing the volume of original coating is in excess of the quantity which can be absorbed by diffusion. The result is then a true diffusion coating plus an outer layer of pure diffusion element, because of the excess of this element. Hot-dip galvanizing is a coating of this nature although the full extent of the diffusion zone is not necessarily realized by the single process.

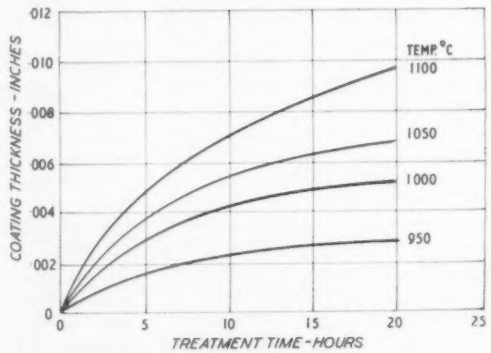


Fig. 1.—Typical performance curves for thickness of chromized coating on low carbon steel

Specific diffusion processes, however, generally aim at producing the coating in a single operation. In the case of chromizing the solute is commonly rendered in the form of the metallic halide—e.g. chloride (usually), bromide, fluoride or iodide—reacting at the surface of the parent metal raised to a suitable temperature. The halide is passed over the surface of the parent metal in vapour form when the deposition of the metallic solute element may occur by reduction, dissociation or interchange, or a combination of all three depending on the ambient conditions. Essentially the process is dependent on reactions in the gaseous phase, whether a chromium halide is employed as such or generated as part of the process from the solute metal or metal alloy. Processing temperatures usually range between 900° C and 1100° C.

In the solid pack method the solute element is employed in solid form, packed in contact with the parts to be treated, a suitable halogen producer (e.g. ammonium halide) and a refractory oxide to act as an inert filler.

In general, under such conditions the reaction developed is primarily one of dissociation where the parent metal acts as a catalyst, plus interchange reaction increasing with increasing processing temperature. The latter becomes the major part with increasing temperature. This is marked by a loss of parent metal from the subject.

With chromized iron surfaces this effect may be negligible and, in fact, most processes tend to produce coatings of similar thickness and characteristics whether the solute metal is originally rendered in solid metallic form or gaseous or semi-gaseous halide. This is not the case with siliconized coatings, however, where the silicon atom is approximately three times as large as the iron atom. In a coating formed by interchange reaction there is an appreciable loss of weight (approximately four parts by weight of iron removed for every one part by weight of silicon diffused into the surface) accompanied by a relatively large increase in dimensions.

Where the silicon diffusion is accomplished by a reduction reaction the growth in dimensions will be greater, but there will be a weight increase instead of a decrease. An interchange reaction is typical of solid pack treatment, where the objects to be treated are packed with ferrosilicon or silcon carbide and an inert refractory filler and then subjected to a stream of chlorine gas at a process temperature of the order of 900° to 1100° C. With gaseous treatment—the silicon being present in the form of silicon tetrachloride—the relative amounts of interchange and reduction reactions are dependent on the gas concentration and the process temperature. High temperatures and high silicon tetrachloride concentrations favour interchange reaction; lower temperatures and lower gas concentration the reduction reaction.

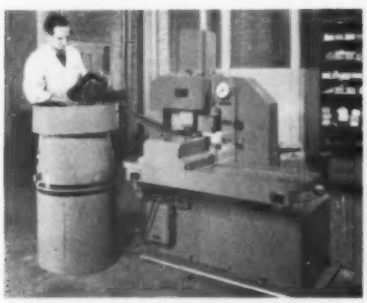
Silicon diffusion has been applied with considerable success to ferrous metals, the average silicon content being about 15% in the diffusion layer with interchange reaction. With reduction reaction the diffusion layer tends to form in two distinct parts, an inner layer with approximately 15% silicon content and an outer layer with an appreciably higher silicon content, the relative thickness of the layers depending on the process temperature and time.

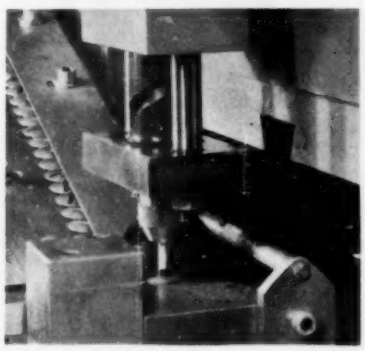
Alloying elements also affect the thickness of the diffusion layer, in particular alloy steels being difficult to siliconize adequately. Indifferent reactions are also obtained with nickel and nickel alloys, although molybdenum can readily be treated. A siliconized surface on molybdenum is a particularly useful treatment for ensuring good resistance to oxidation at elevated service temperatures.

Molybdenum can also be chromized satisfactorily, the method of treatment being essentially the same as that employed with ferrous metals. Nickel, nickel-iron, nickel-copper, nickel-chromium and nickel-molybdenum alloys can also be chromized satisfactorily, although the coatings obtainable on the alloys are usually thinner than those given with the pure metal. The presence of the alloying element appears to retard the diffusion process and at the same time gives a high concentration of chromium in the surface layer. In the case of nickel-copper alloys this can be as high as 70–80%.

With ferrous metal alloys, alloying elements favouring the formation of ferrite tend to promote diffusion to give deeper coatings with lower chromium content whilst austenitic-forming elements inhibit diffusion, resulting in thinner surface layers of higher chromium content. Average diffusion layer content is 20–25% with iron or low carbon steel.

An interesting point which remains yet to be fully explored is that diffusion coatings obtained by interchange reaction tend to be more consistent and have a better covering power than those obtained by reduction reaction. The latter, being dependent on the distribution of the solute element in the form of a gas, is subject to geometric limitations in the gas flow. To overcome such limitations there is the possibility of introducing an interchange reaction on an intermediate surface coating which can readily be applied to the parent metal, the desirable solute element completely replacing the intermediate coating in the form of a true diffusion layer.



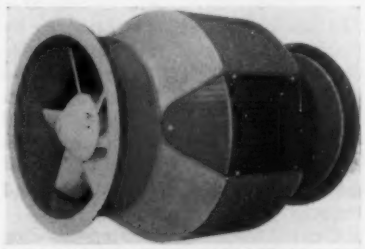


The new Pryor machine for marking the domed head of fasteners and, at right, a close up of the feeding arrangement

Marking Domed Heads

Equipment for marking the domed heads of vibration-absorbing fasteners for sheet metal panels, the marking being done relative to the slot, has recently been developed by Edward Pryor and Son Limited, Broom Street, William Street, Sheffield 10. The equipment involves the use of the E.P.40 automatic press and can mark at the rate of 1200 pieces an hour without an operator.

The E.P.40 machine is used for marking most kinds of ball and roller bearing rings as well as bolt heads, hexagon nuts and similar small articles. One of the features of the machine is that the restriction of the amount of travel of the press rams to an amount sufficient for inserting and discharging the components provides a high output. In some instances a ram movement as little as $\frac{1}{16}$ in. will suffice. The type of component affects the output obtainable but simple shapes such as ball bearing rings permit 2000 pieces per hour and in the standard machine rates of 1000, 1500 and 2000 pieces per hour are provided.



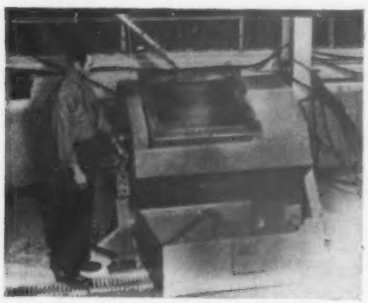
BIFURCATED FAN.—This 18 in. dia Turbo-Cyclone bifurcated fan is one of a variety of sizes up to 30 in. dia in a new range being produced by Turner and Brown Limited, Bolton, in conjunction with Matthews and Yates Limited, Swinton. The blades are of true aerofoil section and are made of rigid P.V.C.

Finishing Small Parts

A new machine and process for the finishing of small parts, to replace rotating barrels, developed by the Pangborne Corporation of America, is to be manufactured in Britain by the Hepburn Conveyor Company Limited, Wakefield. The machine has provision for varying amplitude and varying frequency, enabling a large range of work to be undertaken at greatly increased production rates. Speeds of from 10 to 100 times greater than tumbling barrels are achieved, less media and compounds are used for any given amount of work, and visual operation of the process is possible during operation.

The machine is suitable either for severe cut down or for delicate work.

It makes possible the processing of interiors and shielded surfaces which are unsuitable for barrel cleaning and will carry out cleaning, descaling, deburring, radiusing, fine finishing, colouring, burnishing and ball burnishing. Machines are being made in capacities of 1½, 3, 6, 12 and 18 cu ft and the company are prepared to undertake the supply of a complete process plant, compounds and media.

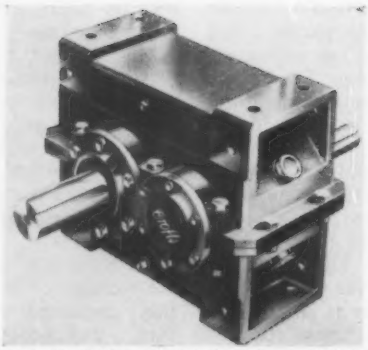


This machine makes possible the finishing of shielded surfaces unsuitable for barrel cleaning

Universal Gear Units

Complete universality of mounting is the principal feature of the new "Par-O-Mount" gear units, made by Crofts (Engineers) Limited, Thornbury, Bradford 3. There are two types—single reduction worm gears and single reduction single helical gears and each is adaptable to a wide variety of mounting positions, shaft dispositions, and ratios of speed reduction.

Gear cases have integrally-cast feet, machined and drilled on all faces. The worm gear case is of one-piece construction, while that for the single helical gears consists of two

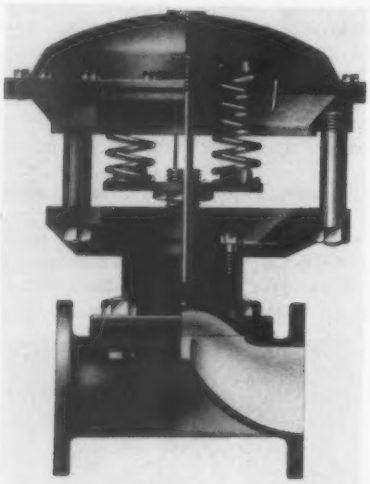


Crofts Par-O-Mount single helical (above) and single worm (right) gear units can be mounted readily in any position

halves, machined and bolted together.

Seven sizes of worm gear, up to 5 in. centres, cater for powers from fractional up to 25 hp. Stock ratios are from 5:1 to 70:1.

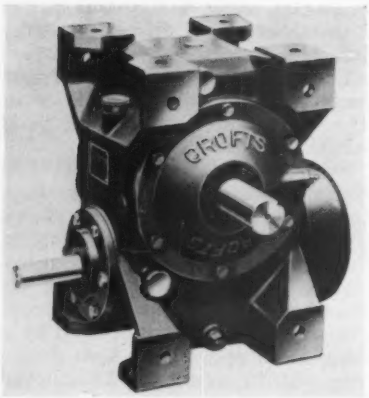
The single helical gears are available in a range of sizes from 3 in. to 10 in. centres, with standard ratios up to 6:1, for powers up to 600 hp.



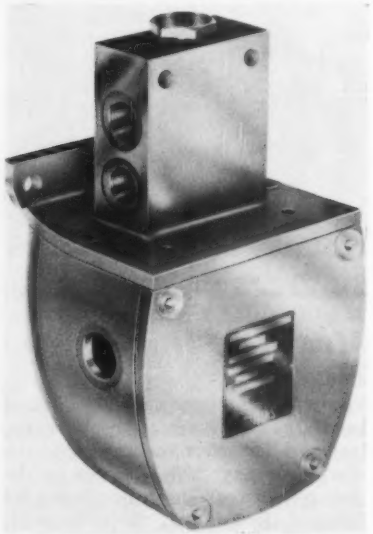
PRESSURE CLOSING VALVE.—This design of diaphragm-operated pressure closing valve, made by Saunders Valve Company Limited, Cwmbran, is applicable to all sizes from ½ in. to 8 in. except ¾ in. and 1¼ in. Pressure admitted above the head diaphragm causes the valve to close against spring and line pressure

Solenoid-operated Hydraulic Valves

A new range of solenoid-operated hydraulic valves recently introduced by Smiths Jacking System, Witney, Oxon., includes a.c. and d.c. operated valves having fluid flow rates of up to 4 gpm at pressures of 3000 psi and either "normally open" or "normally closed" as desired. Two, three or four ports can be incorporated and the coils themselves can be provided for operation over a wide voltage range.



The accompanying illustration shows a "normally closed" solenoid-operated valve designed for operation on a 240 V or 415 V 50 cycle single-phase electrical supply. When energized, the continuously-rated solenoid coil thrusts a balanced poppet valve off its seat permitting fluid flow from the lower to the upper ports at a maximum flow rate of 4 gpm at a pressure of 3000 psi. Notable design features include improved balanced poppet valve permitting high pressure operation with minimum current consumption; "straight-through" ports which facilitate ease of installation and eliminate the need for T-junctions in the hydraulic circuit; and conduit entry in the sturdy casting housing the coil. Under normal conditions the frequency of operations is four per minute, but more frequent operation is permissible provided



"Normally closed" solenoid-operated valve for operation on a 240V or 415V 50 cycle single-phase electrical supply

micronic oil filtration is employed. The recommended oil for use with the valve is a light mineral (or petroleum base) hydraulic oil.

Flame-proof Mines Tractor

Over twenty years ago the Hunslet Engine Company pioneered the use of flame-proof diesel locomotives in safety lamp mines. Since then they have built and supplied more fully flame-proof diesel locomotives than any other maker in America or Great Britain and with their experience have become intimately connected with underground problems. To meet the need for a general purpose machine suitable for operation in the limited space available, Hunslet have now produced a compact flame-proof 25 hp rubber tyred four wheel drive tractor; the first flame-proof tractor in service in a British Colliery.

The tractor is fitted with slew steering which allows great manœuvrability and precision of control enabling it to operate alongside conveyors without damaging either the conveyor or the pit arches. Acute corners can be negotiated, turning radius being only 5 ft 6 in. This type of steering obviates the need for a differential lock and also facilitates the use of a variety of ancillary equipment which can be supplied with the tractor.

The tractor is controlled by a throttle, a forward/reverse selector and two levers, each of which operates the brakes on a pair of wheels. The controls are conveniently arranged for use from alternative driving positions, one for each direction of travel. With this arrangement the driver can always face the direction in which the tractor is moving thus facilitating steering and eliminating blind spots.

A Perkins "Three 152" (see accompanying description) water-cooled three cylinder diesel engine, with chromium plated liners and mechanical governor, is incorporated, derated to develop 25 hp net at 1650 rpm. The engine is started by an hydraulic starter. Transmission from the engine is through a torque converter to an epicyclic forward and reverse gearbox, then through reduction and transfer gearing, multi-plate clutches and worm drives. The worm drives are incorporated in each wheel. This transmission system facilitates the servicing of clutches, brakes and

Hunslet MT 25 flame-proof diesel hydraulic mines tractor

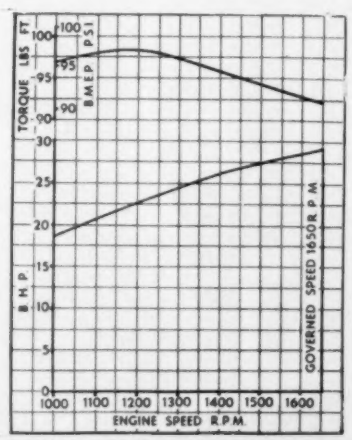
final drive and enables a four wheel drive tractor with large diameter tyres to be built down to a width of 3 ft.

The stainless steel exhaust gas conditioner is constructed on the Hunslet "Jet" principle to ensure maximum cleansing of the exhaust gases and safety of operation even when working over undulating ground. An exhaust conditioner low water level engine shut-off device is fitted and the whole of the exhaust system, including the conditioner, is waterjacketed. The gases from the conditioner are diluted with air from the fan before exhausting to atmosphere.

Maintenance has been reduced to the absolute minimum. Apart from the diesel engine, lubrication is only required at 12-monthly intervals.

The basic tractor incorporates hydraulic pump and the frame is designed for the attachment of an hydraulic linkage to which the following items are quickly fitted: angledozer, low lift shovel 2 ton capacity, fork lift 2 ton capacity, crane, articulated trailer coupling, skid pan coupling.

In addition winches are available driven through the torque converter or by the hydraulic pump.



Characteristics of Perkins Three 152 flame-proofed industrial diesel engine for Hunslet MT 25 mines tractor

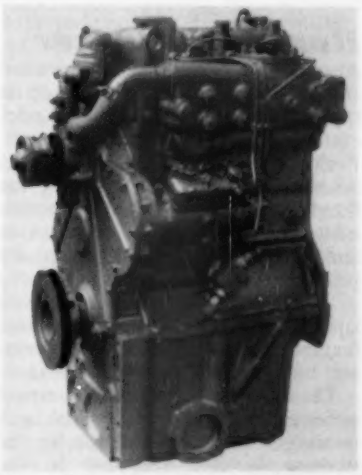
Flame-proof Diesel

A new three cylinder diesel engine suitable for installation in flame-proofed vehicles and industrial equipment is announced by Perkins Engines Limited, Peterborough. Known as the Perkins Three 152 (Flame-proofed), it is built to comply with the Ministry of Power's flame-proofing requirements for units with engines installed. The new engine has been chosen by the Hunslet Engine Company Limited, of Leeds, to power their new MT 25 mines tractor which has already been awarded a Ministry "Buxton certificate".

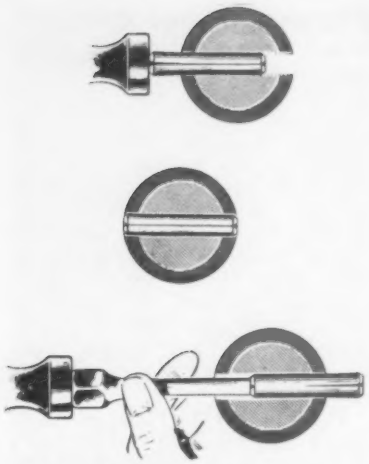
The Three 152 (Flame-proofed), with a capacity of 152 cu in., has a number of special features for flame-proof operation including a water-jacketed exhaust manifold to cool exhaust gases; special cylinder head, gasket, and cylinder head fixing stud holes machined to comply with "Buxton certificate" requirements; specially wide joint facings on the cylinder head for mounting the induction flame trap; fuel atomizer seatings arranged to conform with flame-proofing regulations.

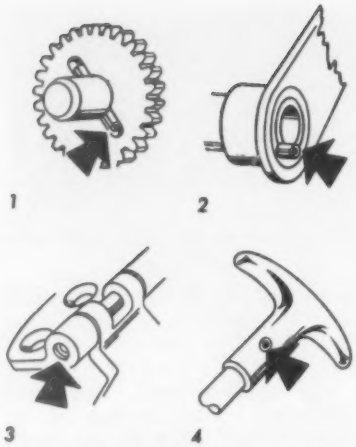
Design features include chrome-plated steel liners to ensure long bore life under the most dusty operating conditions, a rotary fuel pump with an integral mechanical governor, replaceable pre-finished main crankshaft and big-end bearings, and geared timing.

The engine is small enough to be installed in a machine 3 ft wide including wheels, and 3ft 5 in. high. At the same time, it provides the high tractive effort required for haulage and general purposes.



Three cylinder Perkins Three 152 flame-proofed industrial diesel engine





Left, fitting a Rollpin fastener. Above (1) high-shear strength permits use to secure gear. (2) Rollpin replaces a key. (3) A headed pin is replaced by a Rollpin. (4) Rollpin replaces a set screw

Pin Fastener

The setting up of manufacturing facilities for full scale production of the Rollpin, a slotted cylindrical spring pin which replaces screws, rivets, solid pins, taper pins, hinge pins, etc., has been announced by The Tempered Spring Company, Limited, Sheffield.

The Rollpin is easily driven into a hole where its own tension locks it into position. It is unaffected by movement or vibration yet may easily be drifted out if desired. Its slot dimensions, outside diameter and elastic limits are carefully precisioned so that the locking action is achieved in holes drilled to normal production tolerances. For ease of handling it is chamfered at both ends; it will not tangle and may easily be adapted for automatic hopper feed. Heat-treated during production, it has greater resilience and shear strength than the solid pin. Sizes at present available range from $\frac{1}{16}$ in. to $\frac{1}{2}$ in. dia.

Runabout Stacker

A fluid-driven rider-controlled stacker claimed to be the first of its type has been developed by Lodematic Limited, Clitheroe, Lancs. Forks or hand-controlled or weight actuated goods platform can be fitted to the stacker which dispenses with conventional clutch, accelerator and gear box, and is powered by propane or petrol engine or battery or low voltage motor. Manoeuvring is simple, in one twin-point control regulating speed forward and reverse, and lifting, lowering and stopping.

The fluid-driven wheel, of compact self-contained construction, is light in weight and easily turned by the steering handle. Response to the travel control lever is immediate. The stacker has a central neutral position, and can be put from "forward" into "reverse" without pause. When released the control automatically returns to neutral, providing a hydraulic self-braking effect. It can operate in limited headroom and floor space.

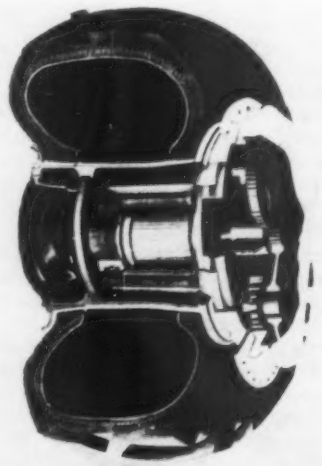
When propane powered, the absence of noxious fumes permits indoor use under normal conditions. Battery models are served by independent or inbuilt charger. Models lifting up to 10 ft are included in the fluid-driven runabout range, and up to 14 ft lift is offered with the manually propelled version. Depending upon the model, the stackers are available with capacities from 100–1000 lb.

Lodematic fluid-driven rider-controlled runabout stacker

Self-powered Wheel

A new self-powered wheel developed by the International General Electric Company of New York, is completely self-contained and requires no other mechanical power connexions. This motorized-wheel makes possible a 125 ton gross weight hauler which has the manœuvrability of a vehicle one-third its size.

It is used with a 10 ft high, tubeless tyre and an electric traction motor and a few gears in the hub give the wheel its driving force. Current for the electric motors is supplied from a diesel engine-driven generator or from a direct-current overhead trolley and each wheel can develop 380 hp at the rim.



This motorized wheel has an electric traction motor as an integral part eliminating transmissions, axles and gear shifts. Power is from a direct-current generator driven by the vehicle's engine

One of the special features is that, should a wheel lose traction in loose mud or snow, the amount of current fed to the wheels that have good purchase is increased. Another feature is the powerful braking system, allowing a vehicle travelling at 35 mph to bring itself to a complete stop within a distance three times its own length.

A motorized-wheel vehicle requires no transmissions, axles or differentials since each wheel contains its own power-producing elements, can use full engine horsepower rating over the entire speed range, will not stall if it meets a momentary excess load, and can

climb grades of 10% or more under full load faster than conventional vehicles of equivalent horsepower.

Trinistor Applications

Trinistors (a trademark of the Westinghouse Electric Corporation) are Westinghouse silicon controlled rectifiers and are used in a number of applications in power control. One of the most remarkable properties of the device is its ability to control several kilowatts whilst requiring only a few milliwatts of control power itself. This means that the actual switch, or variable adjustment available to the user need have only a low power, voltage or current rating. Further, due to the low drive requirements, automatic control may be easily applied. The following examples of Trinistor applications are drawn from the display at this year's Instruments, Electronics and Automation Exhibition.

Trinistor 13 kVA a.c. regulator

Two Trinistors were connected in inverse parallel between the a.c. supply and the load, and the r.m.s. output voltage is varied by controlling the proportion of each half cycle for which the Trinistors conducted.

The load consisted of a number of tungsten lamps with a total maximum consumption of 10kW, built into a sign reading "This 10kW sign is controlled by 2 Westinghouse Trinistors".

The control unit had provision for the power fed to this sign to be varied either manually or automatically, and in addition incorporated an automatic current limiting facility, which in conjunction with fuses afforded protection against overloads.

Trinistor 5kW controllable rectifier

Two Trinistors were incorporated with two silicon junction diodes into a single-phase bridge rectifier, the d.c. output of which was varied by controlling the proportion of each input half cycle for which the Trinistors conducted.

The regulator shown was rated, in an ambient temperature of 30°C, at an output current of 25 amp at up to 200 volt, and was demonstrated controlling the armature voltage of a 4·8 hp motor.

Alternative facilities were provided for either constant potential operation or manual control of the output voltage from zero to maximum. The control unit in addition incorporated a current limiting facility in both cases.

Trinistor 3 hp motor starter

Two Trinistors were connected in inverse parallel between the a.c. supply and the motor and functioned as an on-off switch. Suitable control circuits kept the switch ON after the START button was released and provided full automatic overload protection. The exhibit demonstrated the starting of a 3 hp motor drawing 15 amp at full load and 80 amp at starting, and showed the effect of a simulated motor overload by connecting a low value of resistance across the motor.

Trinistor 1kW single-phase inverter

A parallel inverter circuit embodying two Trinistors generated 1kW of a.c. power at 240 volt, 1000 c/s with a nominal 24 volt d.c. input, and supplied a bank of twelve 80 watt fluorescent tubes. This application demonstrated how Trinistors can be used to provide power in mobile lighting systems.

The full-load efficiency of the inverter was 85% and the load regulation 5% from open-circuit to full load.

There was an improvement in fluorescent tube efficiency due to high frequency operation of about 15%.

Trinistor theatre lamp dimmer

In this demonstration of theatre lighting control, four spotlights, one 2kW and three 1kW, were each controlled by two Trinistors in an inverse parallel a.c. regulator circuit. The control circuits were designed for economical operation of large numbers of lamps, and since they responded to a 5mW d.c. input signal, were adaptable to complex control systems.

The arrangement shown permitted two separate combinations of lights to be set up independently and selected by a master fader.

Trinistor solenoid control

This exhibit demonstrated on-off control of a d.c. solenoid fed from an a.c. supply by means of a single Trinistor in a current-doubler rectifier circuit in conjunction with a silicon diode. The Trinistor was connected between the load and the a.c. supply, and the diode connected across the load. The current doubling action depended upon the load being substantially inductive, and under this condition the load voltage was approximately half the mean supply voltage.

One Trinistor on a suitable cooling fin will switch up to about 5kW, and can be controlled by a gate signal of 125mW.

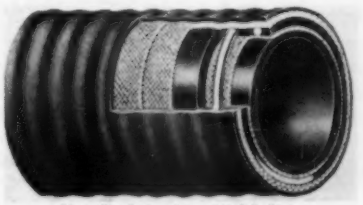
Display of Trinistor characteristics

The voltage/current relationship for a Trinistor was displayed on an oscilloscope and showed both the forward and reverse characteristics. The approach of forward breakover was shown as the anode-cathode voltage was increased, and the effect of gate current on this breakover voltage was demonstrated.

The blocking resistance and reverse resistance were very high, several hundred thousand ohm or more, whilst the forward conducting resistance was very low, of the order of 0·02 ohm.

Trinistor 5kW three-phase inverter

In a three-phase inverter, the d.c. input was switched cyclically by three Trinistors between the outer terminals of a star-connected primary winding on a three-phase transformer, the switching being effected by a three-phase pulse generator in conjunction with commutating capacitors. The unit shown delivered 5kVA of alternating current at 110 volt, 400 c/s with a d.c. supply of 110 volt, at an efficiency of 95%.

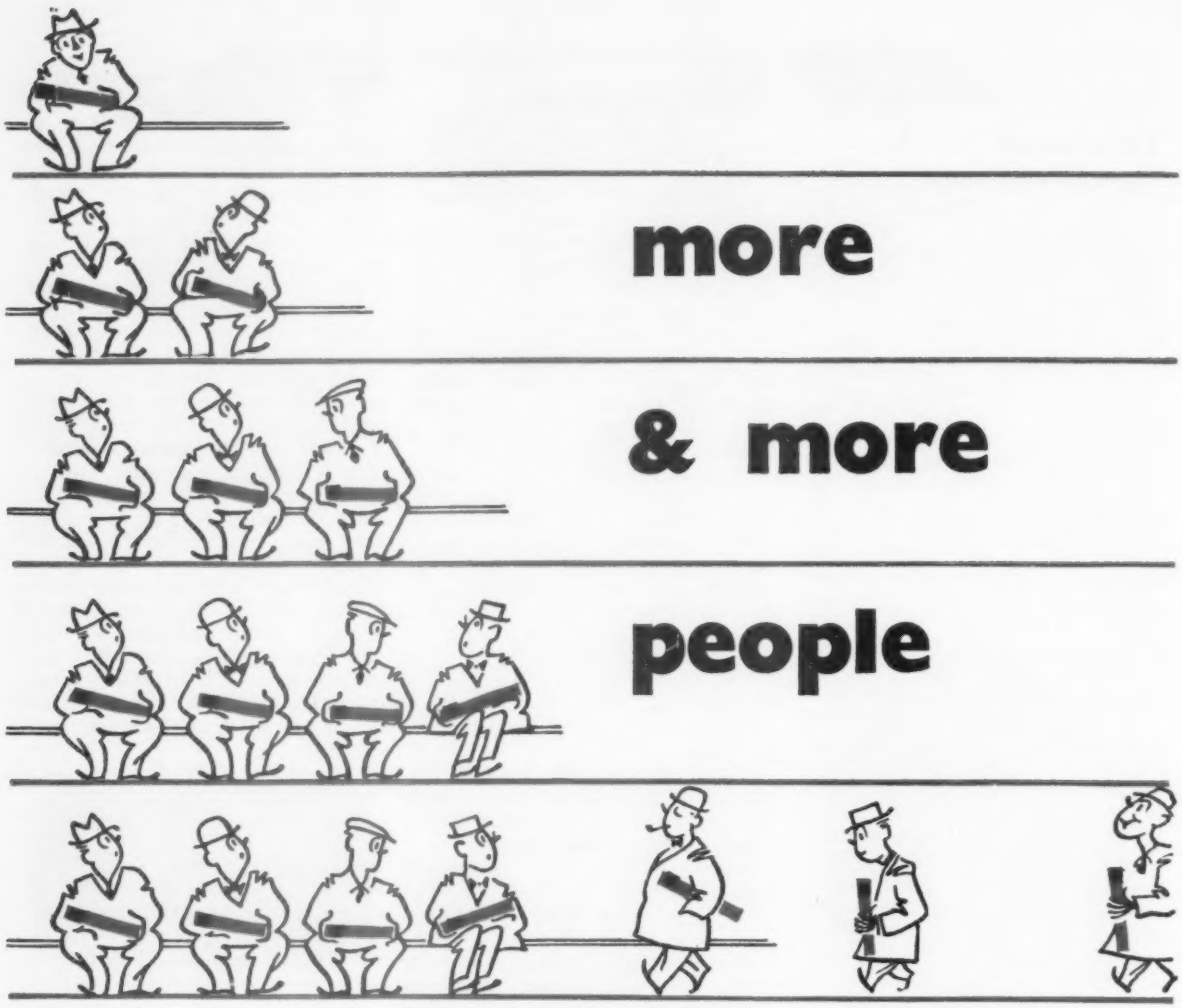


New Goodyear dry materials hose

Dry Materials Hose

A lightweight, flexible hose specially built for the bulk handling of dry materials which are not highly abrasive such as grain, dry chemicals in crystal powder form, fertilizers and similar materials has been added to the range of industrial hoses made by the Goodyear Tyre and Rubber Company Limited, Wolverhampton.

The new hose (style 273 × 243) is supplied in lengths to suit the site and application and can be built with enlarged ends for fitting couplings or with soft ends for clipping to existing pipework or hopper feed tubes. The seamless $\frac{3}{16}$ in. smooth-bore tube of high grade rubber is reinforced by three plies of strong, close woven fabric and a helix of round, steel wire embedded in the rubber whilst the cover consists of a medium-gauge, abrasion-resisting compound. The hose has a maximum working pressure of 50 psi and is supplied in bore sizes of $2\frac{1}{2}$ in. and 4 in.



use Eclipse

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UH 35

books

Engineering Mathematics. By J. Blakey and M. Hutton. London, 1960; Blackie & Son Limited. 40/- net (by post 41/9). 603 pp. $5\frac{3}{4} \times 8\frac{1}{2}$ in.

This new textbook is composed of certain chapters from "University Mathematics", a popular book for students of science and engineering by Dr. Blakey, and chapters contributed by Dr. Hutton, the newly constituted whole being designed to meet the particular needs of engineering students. The text covers calculus, determinants, plane and co-ordinate geometrics, differential equations, spherical trigonometry, moments of inertia, damped simple harmonic motion, numerical solution of equations, statistics, relaxation methods, operational calculus and the Laplace transformation. The difference, therefore, between this book and that first mentioned lies in the removal of some theoretical matter and the addition of some methods of more practical use to the engineer. This makes the book useful for reference as well as for study, and there are plenty of worked examples as well as exercises with answers to aid in its use for both purposes.

Workshop Engineering Practice. Vol. I, Fitting. By H. G. Rider. London, 1960; Iliffe & Sons Limited. 9/6 net (by post 10/1). 150 pp. $5\frac{1}{4} \times 8\frac{1}{4}$ in.

This is the first of a projected series of elementary textbooks on various aspects of workshop engineering. The author is chief instructor in the subject at the Borough Polytechnic, London, and he presents the work in careful detail and with a wealth of explanatory sketches. (Fig. 21, p. 44 and Fig. 4, p. 71 should be turned round.) He describes the tools and explains how to use them, treating in this way hammers and chisels, saws and shears, files, scrapers, screwing tools, reamers, measuring and marking out instruments, and drills. Instructions are given for a complete practical exercise and some rules for ensuring safety in the workshop. A set of coloured filmstrips based on the book has been produced by Film Strip and Slide Distributors Limited, 3a Harrington Road, London SW7.

Broaching. By C. Monday. Brighton, 1960; The Machinery Publishing Company Limited. 18/6 net (by post 19/4). 164 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

This is a new addition to Machinery's Standard Reference Series and, like its companion volumes, its approach is concise and practical. After briefly describing the broaching process and outlining the principles of broach design the author explains the working of modern broaching machines of horizontal, vertical and universal types. The practical applications of internal and external broaching are dealt with separately in long chapters and details are given of the uses of various attachments and fixtures. Broach manufacture and miscellaneous applications of broaching are also covered.

As with so many other methods of machining the development of broaching has been accelerated in recent years and it is used today on a very large scale. This book should satisfy anyone requiring a short up-to-date treatment of the process. It is well illustrated and produced.

Spark Machining. Brighton, 1960; The Machinery Publishing Company Limited. 5/- (by post 5/5). 72 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

Although in the early days of current electric technique many investigators were aware of the material removing properties of the electric spark it is only in recent years that spark machining methods have been developed successfully. In the last eight years this development has been particularly rapid and the practical and economic advantages of spark machining as a finishing process, when used in conjunction with conventional methods, is now widely recognized.

This short book provides a useful introduction to the subject. In three chapters it outlines the basic principles and summarizes recent developments; typical machines are described to show how the essential requirements of the process have been met in design and equipment, and examples are given of particular applications of spark machining to show its use in overcoming difficulties inherent in the material or the shape of the workpieces. The book is well illustrated in line and half-tone.

Scientific Words. By W. E. Flood, M.A., Ph.D. London, 1960; Oldbourne Press. 18/- net (by post 18/10). 220 pp. 5 × 8 in.

People who dislike foreigners, serious music and modern art seldom advance logical reasons for doing so but, in many cases, ignorance of the language—whether it be the language of the Italians, Beethoven or Picasso—is the cause. Similarly there is little doubt that those who hurl abuse at scientists are often motivated by the frustration caused by their feeling lost among a strange race whose language they cannot understand. Yet scientists must use words which are precise and single in meaning and most ordinary words have over the years acquired a variety of meanings. For this reason Dr. Flood's book is particularly welcome for he has provided not only a glossary but an analysis of the language of science.

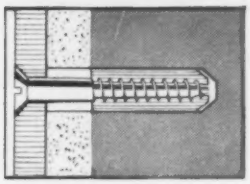
The basic scientific word-elements (roots, prefixes and suffixes) number little more than 1000 and these, with the exception of very common elements, are listed together with their meanings and origins. The use of each element in word building is illustrated by a selection of scientific terms which incorporate the element selected to show the various forms which the element may take and its use in building terms in various sciences. While the glossary is not intended as a scientific dictionary it does, in fact, explain several thousand scientific terms.

Any layman concerned with advancing his scientific knowledge could study this book with profit and it should certainly be of value to scientists, few of whom today are classicists or philologists.

Trade Statistics.—The ninth issue of the United Nations "Yearbook of International Trade Statistics" is in two volumes; the first contains detailed data for individual countries and basic summary tables showing *inter alia* the trade contribution of each country to the trade of its region and of the world during 1958, analyses the flow of trade between countries and describes the fluctuations of the prices; the second volume is primarily for users interested in the broader economic aspects of external trade and con-

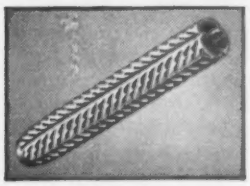
RAWLPLUG FIXING DEVICES and TOOLS . . .

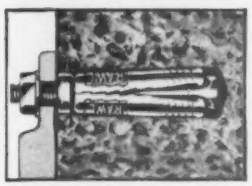
Backed by the Name that Carries the Weight



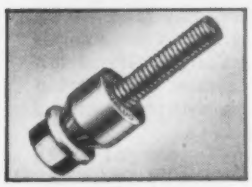
For firm Screw Fixings. The specially treated fibrous construction of the Rawlplug provides the most effective stronghold for wood-screws in any masonry. The simple method of making the hole, inserting the Rawlplug and driving home the screw enables firm fixings to be made quickly without mess or damage to walls or decorations. Sizes are from the tiny No. 3 to the 1″ diameter No. 30.

On the occasions where a metal plug is preferred or advised, such as for wet or acid situations, there is the choice of Rawlplug Screw Anchors or White Bronze Plugs, but for these Cadmium plated screws should be used.

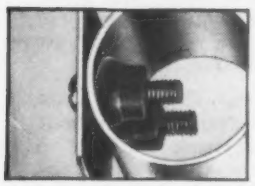




Heavy Duty Fixings. RAWLBOLTS are expansion bolts which only require a hole in the masonry in the same way as a Rawlplug. By turning the bolt the metal segments are locked within the hole and the fixing will take very heavy loads with complete safety. Sizes are from 3/16″ to 1″ diameter.

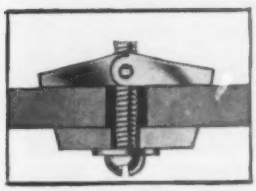


Wet or Acid Situations. Rawlplug Bolt Anchors and Rawltamps are made for heavy duty bolt fixings in places where the exposure to corrosion is extremely high. The Bolt Anchor can be set deep down in thick concrete whereas the Rawltamp enables a threaded insert to be fixed in shallow concrete.

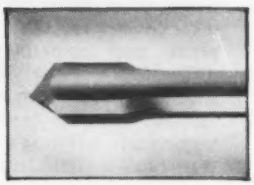


Thin or Cavity Walls. Proprietary building materials often present fixing problems because of being either hard and thin or thick and soft. The Rawlplug Company have devised several clever devices for making firm fixings to such materials including lath and plaster ceilings, hollow pot, panel doors, etc.

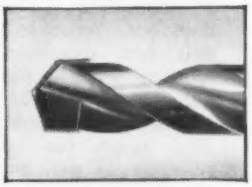
The upper illustration shows how one of the devices will make the almost impossible fixing of a metal plate to a pipe and the bottom illustration shows how the wings of a Spring Toggle spread the load over a plasterboard ceiling.



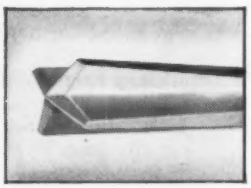
Rawldrills. Standard sizes for Rawlplugs Nos. 3 to 30 and Rawlbolts A. B. C. D. E. and G. Adaptable Rawldrills need only three holders for the 10 sizes Nos. 3 to 22. There is also a very useful Universal Tool-set with a knurled holder to take Universal Rawldrills Nos. 6 to 20.



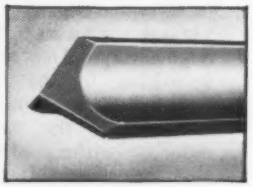
Durium tipped Drills. For faster, silent penetration of masonry and tiles Durium drills are the answer. They can be used in hand or suitable electric drills. Sizes for Rawlplugs Nos. 6 to 30; for C. D. E. and G. Rawlbolts, and a long series for drilling right through walls. Free resharpening Voucher given with every Durium drill.



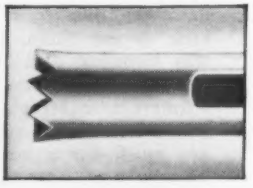
Rawlplug Stardrills. An inexpensive one piece tool for use on jobs needing a small number of holes. Twenty sizes from 11/32″ to 2½″ are made, of which eight are for Rawlbolts "A" to "K", and it is only necessary to quote the reference letters of the Rawlbolts when ordering Stardrills to use with them.



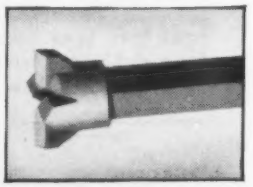
Wall Boring Tools. Specially designed for rapid boring right through walls. This triple fluted percussion tool with hexagon handle in one complete unit has been proved to make a ¾″ hole right through a 9″ stock brick wall in nine minutes. Lengths 18″ and 24″, diameters from 5/16″ to 1½″.



Tubular Boring Tools. Will bore a clean hole in soft brick wall quicker than any other hand percussion tool. The serrated edges saw through masonry and the dust is collected in the channel and ejected through the elongated slot. When working in deep holes the tool should be withdrawn periodically and the dust tapped out. Sizes are from ¼″ to 1″ diameter.



Power Tools. In addition to the hand tools listed above special Rawlplug tools are made for use in electric and pneumatic power tools. Details of these can be had on application.



Rawlplug Fixing Devices and Hole Boring Tools are sold by Ironmongers, Hardware Dealers, Builders Merchants and Stores. If you experience any difficulty in obtaining the type and size you require please send details to the following address.

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THE RAWLPLUG COMPANY LIMITED, CROMWELL ROAD, LONDON, S.W.7

tains tables summarizing world trade in terms of United States dollars. The prices of the two volumes which can be obtained from H.M. Stationery Office, P.O. Box 569, London SE1, are 42/6 and 14/- respectively.

World Industrial Acitivity.—The level of world industrial output in 1959, excluding Eastern Europe and China, was about two and one-half times that in 1938 and substantially above the 1957 level, the previous high point in industrial activity. This information is contained in the United Nations Statistical Yearbook for 1959 (H.M. Stationery Office, P.O. Box 569, London SE1, cloth 71/-, paper 57/-) which in addition to providing world industrial statistics, has international tables relating, among other items, to population, manpower, wages and prices, finance and banking, internal and external trade, and transport.

B.E.A. Handbook.—Now in its thirty-first edition, the British Engineers' Association's classified handbook of members continues to provide valuable guidance for those wishing to place orders or enquire for engineering plant, machinery and accessories of British manufacture. The handbook is in four sections: an alphabetical list of members, their addresses, range of products, overseas agents, etc.; displayed announcements by members; a classified list of manufactures with indices in French, German, Spanish and Portuguese; trade names and marks. The price of the handbook is 21/- and it is published by the B.E.A. at 32 Victoria Street, London SW1.

Job Evaluation.—The problem of assessing a fair day's pay is one as old as industry itself. It is unlikely there will ever be a perfect solution but in one respect something definite can be done and that is to ensure that in any one factory all the wage-earners are fairly paid, relatively to each other. Those interested in finding out how this may be achieved can start by reading "Job Evaluation" by J. Walker Morris, A.M.I.Prod.E., one of a series of booklets published jointly by the Industrial Administration Group and the Institute of Industrial Supervisors, 24 Albert Street, Birmingham 4. Intended mainly for supervisory staff, the booklet explains in straightforward language two of the more popular systems of job evaluation. The price is 3/-, including postage.

Russian Welding.—According to a recent issue of the Russian Welding journal, "Avtomaticheskaya Svarka" the U.S.S.R. leads the rest of Europe in the use of mechanized welding methods and has outstripped the U.S.A. in the employment of submerged arc and electro-slag welding. The journal intends to publish a series of articles relative to welding industry mechanization and automation which it hopes will draw comments from all concerned with welding in the Soviet Union. English cover-to-cover translations of this and another Russian welding journal are published under the titles of "Automatic Welding" and "Welding Production" respectively. by the British Welding Research Association, Abington Hall, Cambridge. The respective subscription rates are £10/10/0 and £5.

Report on Research.—The research report of the Royal College of Science and Technology, Glasgow, for the 1958-9 session provides brief accounts of the research work in progress in the various departments, a list of the more important publications by staff members, and the titles of theses approved for higher degrees. Many of the researches have been sponsored by both public and private industrial concerns. Three projects in the Department of Mining Engineering are sponsored by the National Coal Board and in the Department of Mechanical, Civil and Chemical Engineering, the British Shipbuilding Research Association are sponsoring a new research concerned with the fatigue strength of stud assemblies under conditions of loading.

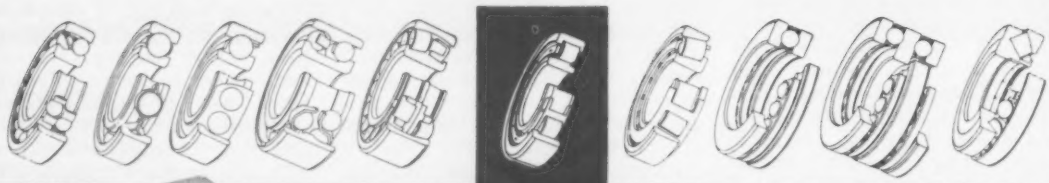
Riveted Connexions.—The University of Illinois Engineering Experiment Station Bulletin No. 454, comprises a report by William H. Munse of an investigation into the effect of bearing pressure on the static strength of riveted connexions. For the investigation tensile and compression tests of 131 riveted joints were made and it was found that under static tensile loading, the ultimate strength was not reduced as a result of permitting the bearing stress to equal 2·25 times the tensile stress; nor, under static compression loading by permitting it to equal 3·0 times the rivet shearing stress. The bulletin, priced one dollar, can be obtained from the Engineering Publications Office, 114 Civil Engineering Hall, University of Illinois, Urbana, Illinois.

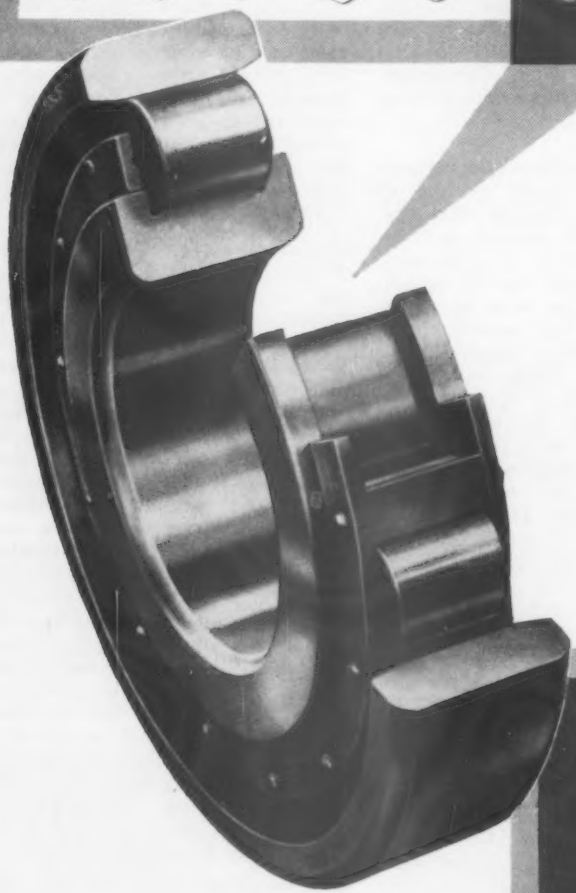
Kompass Register.—A comprehensive and authoritative register of the whole of British industry and commerce is to be published in a three-volume edition in mid-1961. The Kompass register is one of a family now being compiled in most Western European countries, Swiss, Swedish and Spanish editions having already appeared. It will cover all industries and every firm will be included, free of charge, with products and services given in five languages as well as some basic company information. There will be a comprehensive classification of products and services developed in consultation with major firms and trade and research associations. In addition to the free entries, firms can have additional information printed at a charge which includes translation. The price of the set of registers will be £15/15/0 and a rate card and other information can be obtained from Kompass Register Limited, Dowgate Works, Tonbridge, Kent.

Machinery Exports.—In November 1958 the Machinery Committee of the Organization for European Economic Co-operation decided to turn its attention to the new problems facing European exporters of engineering products in competition with non-member countries on third markets, particularly in less industrialised countries. Since then, two statistical pilot studies have been made, one dealing with Latin America and one with India, and these are contained in a booklet, "The Demand for Engineering Products in Less Industrialised Countries—Studies on Latin America and India", which the organization has recently issued. Although based on information already published, the concise presentation of facts makes the booklet of considerable value to exporters of engineering goods. Copies may be obtained, free of charge, from the Secretary, Machinery Committee, O.E.E.C., 2 rue Andre Pascal, Paris 16ème.

Hydromechanics Research.—A new apparatus for testing mechanical and radial-face seals, capable of testing four seals simultaneously, was constructed last year at the laboratory of the British Hydromechanics Research Association, Harlow, Essex. This is one of the research projects described in the association's annual report for 1958-9. Details are also given of about 20 other projects together with lists of members, publications issued, etc.

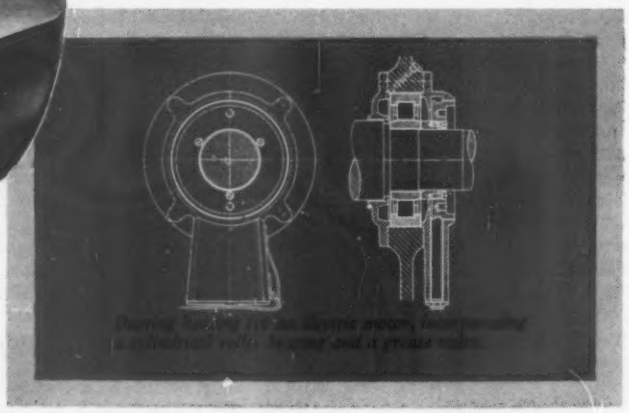
Only SKF can offer such a wide selection of British made bearings





Illustrated on the left is the SKF cylindrical roller bearing, one of the ten variants of the four basic types of rolling bearing manufactured in Great Britain by The Skefko Ball Bearing Co. Ltd. The cylindrical roller bearing has a low coefficient of friction and is therefore suitable for shafts operating at high speeds. Because of its high radial carrying capacity it is extensively used in electric motors, gearboxes and similar applications.

Behind every SKF bearing lies unrivalled experience in the design and application of rolling bearings all over the world. This experience is at your disposal from any one of Skefko's twenty Branch Offices, situated at strategic points all over the British Isles.



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BUSINESS & PROFESSIONAL

Personal

Mr. Frederick Baillie, who has joined the Cambridge Instrument Company as production manager, will be responsible for all aspects of production planning at the company's three factories in the United Kingdom.

THE GENERAL ELECTRIC COMPANY LIMITED, Engineering Group, announce that it has reorganized its representation at the Company's Branches in Great Britain under five Area Chief Engineers: **Mr. E. W. Molesworth,** London, Eastern and Southern England; **Mr. J. R. Mercer,** Scotland; **Mr. V. F. Ellison,** Yorkshire and the North East; **Mr. O. S. Chalmers,** North Western and North Wales; **Mr. W. R. Greves,** Midlands and South Wales.

METAL INDUSTRIES LIMITED announce the appointment of **Mr. F. H. Schroeder, M.I.Mech.E., A.M.I.E.E.,** to the board. For many years he has been a director of Lancashire Dynamo Holdings Limited. **Mr. J. E. Yates** has been appointed general sales manager of Lancashire Dynamo & Crypto Limited, a company in the Metal Industries Group. **Mr. H. G. Boullen** remains sales director, operating from London.

THE BRIGHTSIDE FOUNDRY AND ENGINEERING Company Limited, of Ecclesfield, announce the appointment of **Mr. G. E. Robinson** as general sales manager; **Mr. G. H. Lewis** as sales manager, foundry division and **Mr. T. Hessey** as technical sales manager.

HONEYWELL CONTROLS LIMITED, announce the appointment of **Mr. A. Gordon, B.Sc., A.M.I.Prod.E., A.H.-W.C.,** as manager of the new production engineering department at their Newhouse (Lancs) factory. **Mr. J. Hughes, B.Sc.,** has been appointed quality manager of the Newhouse Works.

ATLAS COPCO (GREAT BRITAIN) LIMITED announce the appointments of **Mr. A. Hayes** as chief sales engineer for mining products in Great Britain; **Mr. W. T. Jones,** manager of mining division; **Mr. R. Marshall,** technical representative; **Mr. Ralph Noren** manager for stationary compressor sales; **Mr. T. M. Horn** who was, until his retirement at the end of 1959, manager of the company's Leeds branch, is maintaining his contact in an advisory capacity.

THE PERKINS GROUP announce that **Mr. G. E. Smith,** director of production, has accepted an appointment as assistant managing director of the Hamworthy Engineering Company Limited. **Mr. T. H. R. Perkins,** managing director of Perkins Engines Limited will act as director of production and will assume full responsibility from Mr. Smith. **Mr. J. M. Collins,** export sales manager of Perkins Engines Limited, will become acting director of marketing for the Perkins Group of companies, and Mr. Perkins will temporarily relinquish his responsibility for all marketing activities within the Perkins Group. **Mr. B. A. Gomm** has been appointed general manager of F. Perkins (Australia) Pty Limited, of Dandenong, Australia. He has been succeeded as general manager in South Africa by **Mr. A. M. B. Cross,** formerly Brisbane branch manager for F. Perkins (Australia) Pty Limited.

THE new chairman of Metal Cleaning Limited is **Mr. Leonard M. Broadway,** who is deputy chairman and managing director of Castrol Limited. **Mr. J. A. V. Watson, O.B.E.,** another Castrol director, is deputy chairman of Metal Cleaning Limited, and **Mr. Arthur Owen** is managing director. The other members of the new board are **Mr. E. B. Bishop, F.C.W.A., A.C.I.S., Mr. J. C. Cragg, B.Sc., F.R.I.C., F.Inst.Pet., Mr. George Owen** and **Mr. G. J. B. Williams** who is also secretary to the company.

Mr. S. H. Oliver has been appointed manager of the purchasing department of Castrol Limited in succession to the late Mr .A. J. Stafford.

Mr. Paul Goudine, M.A., managing director of Electronic Instruments has joined the board of Cambridge Instrument Company Limited. **Dr. P. Dunsheath, C.B.E.,** chairman, Cambridge Instrument Company Limited, **Mr. H. C. Pritchard, B.A.,** managing director, and **Mr. W. E. Lamb,** director, have joined the board of Electronic Instruments, Limited of which **Mr. A. C. W. Norman, O.B.E.,** will continue to be chairman, **Mr. Paul Goudine, M.A.,** managing director and **Mr. D. A. Pitman,** sales director.

Mr. William Colley Monckton Matterson, founder and joint managing director of Matterson Limited, of Rochdale, was awarded a degree of Master of Science (*honoris causa*) at the Congregation for the Conferment of Honorary Degrees at the University of Leeds.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED Motor and Control Gear Division, announce the appointment of **Mr. J. A. Brooks, B.Sc.(Eng.), A.M.Inst.W.,** as divisional assistant manufacturing manager. Mr. Brooks will retain, for the time being, his position as superintendent, Large Industrial Machines Department, Mosley Road Works, Manchester, but will eventually be located at Rugby to devote his full time to his new duties.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED Traction Division, announce the appointments of: **Mr. J. H. Cansdale, M.I.E.E., M.I.Loco.E.,** as sales manager; **Mr. J. C. Way, A.M.I.E.E., A.M.I.Loco.E.,** as deputy sales manager, and **Mr. J. Rostron, M.I.Loco.E.,** as assistant sales manager.

Sir William Jackson, F.R.S., director of research and education of Associated Electrical Industries (Manchester) Limited, is to return to academic life as Professor of Electrical Engineering at Imperial College, University of London.

THE UNITED STEEL COMPANIES LIMITED, announce that **Mr. E. B. Rees,** acting on medical advice, has resigned as export manager. Mr. Rees will continue to act as consultant to the company on export matters. **Mr. H. A. A. While,** manager of the company's London office, has been appointed general export manager. He will continue to be responsible for the railways department. **Mr. F. A. Platts** will succeed Mr. While as London office manager.

THE WORKINGTON IRON AND STEEL COMPANY branch of The United Steel Companies Limited announce a number of new appointments. **Mr. H. M. Henderson,** has been appointed director and general manager. He succeeds **Mr. T. S. Kilpatrick** who, becomes director and general manager of the Steel, Peech and Tozer branch on August 1st. **Mr. H. Darnell** has been appointed a director and **Mr. D. R. Ward Jones** a director of United Coke and Chemicals Limited. **Mr. T. Sanderson** has been appointed deputy general manager. **Mr. H. Darnell** succeeds **Mr. Sanderson** as general works manager. **Mr. G. Pott,** at present works engineer, is to become chief engineer. **Mr. W. Hunter,** blast furnace manager, is appointed ironworks superintendent, with responsibility for ore preparation and blast furnaces. **Mr. F. Greenhalgh** succeeds **Mr. Hunter** as blast furnace manager. **Mr. J. D. Young,** Bessemer manager, becomes assistant steelworks superintendent, and is succeeded as Bessemer manager by **Mr. G. Forster,** at present Bessemer shift manager.

SAMUEL FOX AND COMPANY LIMITED announce that **Mr. G. Thickett,** who has been combining his duties as works manager (heavy departments) with those of billet mill manager, will relinquish the latter appointment. **Mr. E. Hampshire,** at present production controller, is appointed billet mill manager. **Mr. N. P. Bromiley** is

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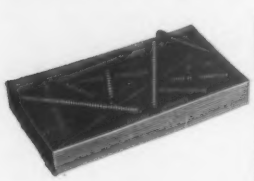
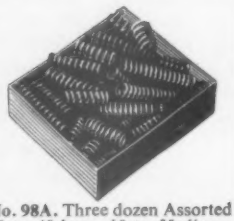
No. 1217. One gross Assorted Springs. A complete Garage Service Kit. 42/- each.

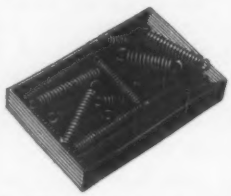
If not, try another box in the Terry Assorted Springs range



No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**

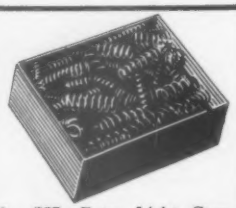


No. 98A. Three dozen Assorted 1" to 4" long, $\frac{1}{2}$" to $\frac{3}{4}$" diam., 19G to 15G. **5/6.**

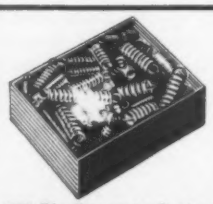


No. 753. Three dozen Assorted Light Expansion $\frac{1}{2}$" to $\frac{1}{2}$" diam., 2" to 6" long, 22 to 18 S.W.G. **10/6.**

No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., $\frac{1}{4}$" to $\frac{1}{2}$" diam. **6/6.**



No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{8}$" to $\frac{3}{4}$" diam., $\frac{1}{2}$" to 2$\frac{1}{2}$" long, 27 to 19 S.W.G. **15/-.**



No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{2}$" to $\frac{1}{2}$" diam., $\frac{1}{2}$" to 2" long, 27 to 20 S.W.G. **15/-.**

We know *exactly* how difficult it is to find springs for experimental work . . . we've been making quality springs for over 100 years. So, we confidently offer you our excellent range of small boxed assortments which covers a very wide range.
We can only show a *few* boxes. Send us a p.c. for our full list.
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appointed production controller. **Mr. C. Gray,** assistant to the bar and rod mill manager, becomes assistant manager, bar and rod mill.

THE board of Dawe Instruments Limited is reconstituted and with the resignation of **Mr. E. C. Kent** and **Mr. A. D. Wells** is now as follows: **Mr. G. E. Liardet,** chairman; **Mr. F. W. Dawe,** managing director; **Mr. J. Ayres, Mr. M. A. Hassid and Mr. K. G. Smith.**

WOLF ELECTRIC TOOLS LIMITED announce the appointment of **Mr. Hans Mäder** as sales supervisor for Switzerland—one of the oldest established markets for their industrial and domestic range of power tools. Mr. Mäder's address is: Bürenstr 33, Lengnau. b. Biel, Switzerland.

Mr. G. Sims-Davies, M.I.Mech.E., has taken up an appointment as general manager of Hancock & Co. (Engineers) Limited, of Progress Way, Croydon, Surrey.

Mr. Arthur James Burton, formerly director of manufacture for the British Motor Corporation's Midland factories and works director of the Austin Motor Company has joined the headquarters staff of the B.S.A. Company Limited, as director of manufacturing services.

ADAMS POWEL EQUIPMENT LIMITED, of Gateshead-on-Tyne announce that **Mr. H. Watson,** of 2 Holmfield Avenue, Moston, Manchester 9, has been appointed technical representative for the Midlands and part of the north of England—Lancashire, Yorkshire and the north west coast.

TUBE INVESTMENTS LIMITED announce that **Mr. W. W. Hackett, Snr., C.B.E.,** on retiring from the chairmanship of Accles & Pollock Limited after 61 years' service with that company, which he helped to found, has accepted an invitation to become its first president.

Mr. W. A. Cusins, London manager, has been appointed export sales manager with Belliss & Marcom Limited, and will be responsible for all sales in the Commonwealth and foreign markets. **Mr. B. Noble,** assistant sales manager, has been appointed home sales manager and will be responsible for the sales organization in Great Britain.

Mr. C. W. Allin has resigned from the board of Redler Industries Limited and its subsidiary companies. At the time of his resignation Mr. Allin was joint managing director of Redler Conveyors Limited and Conveyors (Readybuilt) Limited and his resignation severs a connection with this group of companies of nearly 26 years.

HOLMAN BROTHERS LIMITED announce that **Mr. H. S. Warwick** has been appointed manager of the West African branch with headquarters at Takoradi in Ghana. He takes over at Takoradi from **Mr. A. Vernon Gallie** who has retired after completing 25 years' service as manager.

Mr. Godfrey E. Liardet, chairman and managing director of the Simms Motor & Electronics Corporation Limited has recently been appointed to the board of Roadless Traction Limited of Hounslow, Middlesex.

THE GOODYEAR TYRE & RUBBER COMPANY (Gt. Britain) Limited announce that **Mr. W. U. Chapman,** who has for the past 16 years been manager of the industrial products department, has been transferred to the export sales division of the company. **Mr. J. T. Pearson** succeeds Mr. Chapman as manager of the industrial products department.

Mr. Robert Bradley has joined Stanley Works (G.B.) Limited, Rutland Road, Sheffield, as chief planning engineer.

G. A. HARVEY & CO. (LONDON) LIMITED announce the appointment of **Mr. D. A. F. Donald,** chairman and managing director of National Cash Register Company Limited, has been appointed chairman of G. A. Harvey & Co. (London) Limited. **Sir Thomas Overy** has resigned the chairmanship on medical advice, but remains a director of the company.

Mr. B. J. Reynolds is manager of the new branch office of the F'ag Bearing Company Limited at 36 Mansel Street, Swansea, and **Mr. E. Parkin** is manager of the company's other new office at 35 Call Street, Leeds 1.

REED BROTHERS (ENGINEERING) LIMITED announce the appointments of **Mr. K. R. Boreham** as general sales manager; **Mr. G. Fenton,** northern area representative; **Mr. D. W. Hodgkiss,** midlands area representative; **Mr. J. E. Spellar,** London and home counties representative, and **Mr. F. G. O'Hagan,** Scottish representative.

Mr. T. H. Cook, B.Sc.(Eng.), M.I.E.E., has been appointed chief applications engineer of The Morgan Crucible Company Limited. Previously carbon department technical sales promotion manager, he has travelled widely for Morgans, and will be attending the New Delhi meeting of the I.E.C. in November.

Addresses

CHASESIDE ENGINEERING COMPANY LIMITED announce that all service matters relating to Lancashire and Yorkshire will now be dealt with from Service Division, Philips Road, Blackburn, Lancashire.

ROWNSONS (CONVEYORS) LIMITED who have become members of the Baker Perkins Group will be known as Rownson Conveyors Limited.

STREAM-LINE FILTERS LIMITED, HenleyPark, Normandy, Nr. Guildford, Surrey, announce that their telephone number is Normandy (Surrey) 3311/2 and 3.

GEORGE WIMPEY & CO. LIMITED have acquired Flyover House, the 12-storey office block at the point where the Great West Road approaches the Chiswick Flyover to house staff dealing with design and procurement of chemical plants and oil refineries.

FAIRBANKS-MORSE & COMPANY, a subsidiary of the Fairbanks Whitney Corporation of New York, has now established an electronics division to co-ordinate the company's present domestic engineering manufacturing and sales activities in this field, and the marketing of British products manufactured by E.M.I. Electronics Limited.

THE NORTHERN CONSTRUCTION COMPANY Limited, of Nigeria, is a new company in process of formation, and will consist of the following partners: the Northern Region Development Corporation, Taylor Woodrow (Overseas) Limited, and The United Africa Company Limited. The management of the Company will be provided by Taylor Woodrow.

LLOYD DOIG & CO. LIMITED have moved to larger offices and to a new factory at 64/66 London Road, Cheltenham.

THE TESA DIVISION OF MATCHLESS Machines Limited, 18 Bolton Street, London, W.1, wish to announce that the Tesamic internal micrometer for measuring blind and special bores, manufactured by TESA S.A. Switzerland has now been renamed Tri-o-Bor internal measuring micrometer.

S. AND J. KITCHEN LIMITED, of Broadfields, Sheffield 8, are moving into a new factory in Brimington Road, Chesterfield.

PERKINS ENGINES LIMITED has set up a parts merchandizing branch within its service department. Manager of the new branch is Mr. G. H. Yarnold, formerly export service manager, who joined Perkins in 1946.

FURNIVAL & CO. LIMITED announce that a separate company has been formed to manufacture and sell Andantex reduction units: Andantex Limited, Andantex House, Tamworth Street, Higher Openshaw, Manchester 11. Tel: EASt 1030.

METROPOLITAN-VICKERS—GRS LIMITED, manufacturing power-operated railway signalling and marshalling yard equipment, has changed its name to Associated Electrical Industries—GRS Limited, and will carry on all its operations under that name in future.

Dielectric Heating-3

Some further details of the uses to which dielectric heating can be put are given in this data sheet, being continued from data sheet No. 11.

The Woodworking Industry

A most important development in recent years in the woodworking industry has been the introduction of synthetic resin adhesives of the thermosetting type for the bonding and adhesion of wooden components.

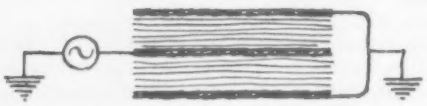
Setting of these resin adhesives proceeds at a rate largely determined by temperature. For instance, urea formaldehyde, one of the resins in common use, sets as follows:

TEMPERATURE	SETTING TIME
65°F	3 hours
80°F	1 hour
150°F	3 minutes
190°F	1 minute

The resultant bonded joint is equally satisfactory in each case. Most of the power supplied when dielectric heating is used is absorbed by the resin, the heat thus being concentrated where required and power consumption reduced to a minimum.

Plywood

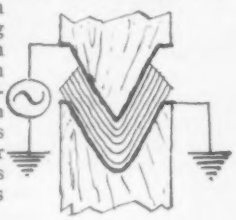
With dielectric heating consuming power only during the heating cycle, plywood can be produced with considerable savings in heating times and costs.



For example, in a press holding 100 3-ply ½" thick assemblies, the resin glue is set in 20 to 30 minutes, depending upon the dryness of the wood. An output of up to 60 cu. ft. of plywood is obtained per hour using a 25 kW H.F. generator.

Curved Laminated Sections

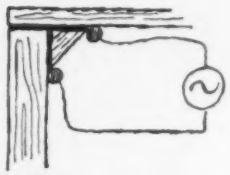
Curved laminated sections are being increasingly used in contemporary furniture, and with dielectric heating rapid production can be achieved using wooden shaping blocks in single daylight presses. An alternative method of providing heat by conduction from heated metal strips becomes increasingly slower as the total section thickness rises above 0.05 inch, as shown below:



TOTAL THICKNESS OF LAMINATIONS	*Comparative heating times in minutes*	
	CONDUCTION	DIELECTRIC
1 inch	20	4
¾ inch	5½	2½
0.6 mm veneer	1	1½

Furniture Assembly

Because of the savings in glueing processes already instanced, dielectric heating is being extensively used in the furniture trade. It leads also to reductions in labour and floor space, with the elimination of assembly jigs. The heating equipment can be placed directly in the production line, cutting handling to a minimum.



Resin-bonded Wood Chipboard

A substitute for natural timber is made from wood waste and chippings, broken down to a coarse size, mixed with synthetic resin and heated under pressure. Dielectric heating gives quick and uniform heating, and increased fluidity reduces the power required for the final pressing and curing operation. In a continuous process, the length of the press required is also reduced.

Blockboard

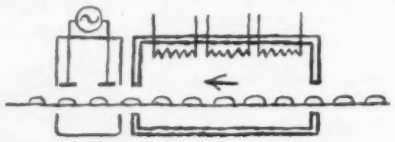
Production of blockboard by edge glueing strips of wood also provides an excellent use for dielectric heating, since considerable savings in time and labour can be effected owing to the large areas of glue line involved.

Other Resin-bonded Products

Dielectric heating is also used in the manufacture of other resin-bonded or impregnated products such as grinding wheels, impregnated woods, fabrics, felts, glass-fibre and similar products.

Foodstuffs

Increased use is being made of dielectric heating in many processes connected with foods; these include de-freezing and melting, sterilisation and disinfestation, drying of breakfast cereals, dog biscuits, rusks etc., heating of nuts to facilitate shelling and other similar types of application. Although some cooking processes are technically



possible, as for example bread baking, the 'unbrowned' product has so far proved unacceptable to the public and a completely dielectric process uneconomical. When combined with conventional baking, however, as now in the biscuit trade, where dielectric heating is being used to complete the baking of biscuits, it can produce normal biscuits in ⅓ to ½ the usual baking time.

There are in fact so many potential applications of dielectric heating (and these applications are increasing daily as the chemical industry develops new products, as for example synthetic fibres) that the selection given in the present series of data sheets covers only a part of the whole field.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available—"Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

7548 A

THE L. S. STARRETT COMPANY LIMITED, a subsidiary company of the American firm, have begun production at Jedburgh, Roxburghshire.

THE new head office of Howard Farrow Limited is at: Highfield Road, Golders Green Road, London NW11. Tel: MEA 3232.

HIGH DUTY ALLOYS LIMITED have transferred their Birmingham sales office from Queen's College Chambers, Paradise Street, to 369 City Road, Edgbaston, Birmingham 16. Tel: Bearwood 2344/5

THE head office of Malcolm & Allan (London) Limited, electrical contractors, has been moved to 229 High Street, Acton, London W3. Tel: Acorn 7811.

C. C. WAKEFIELD & CO. LIMITED, is to be known as Castrol Limited. The company explains that with the post war generation it is the name Castrol which has the greater significance and it is to simplify the work and the identity of the group as a whole that they have, with reluctance, decided to lay aside the "family" name.

METAL CLEANING LIMITED is the new name given to the recently acquired subsidiary of the Castrol Group. The previous title of De-Corrosion Services (Norwest) Limited, has been discontinued.

THE sales department of the Veno Division of Joseph Sankey & Sons Limited has moved from the Hadley Castle Works, Wellington, Shropshire, to 168 Regent Street, London W1.

THE WITTON MOULDED INSULATION WORKS of The General Electric Company Limited, of Birmingham (part of G.E.C. Engineering Group) is now to be known as G.E.C. Moulded Plastics Division.

WALKER, CROSSWELLER & CO. LIMITED, Whaddon Works, Cheltenham, Glos., announce that their telephone number is now Cheltenham 56366 (4 lines).

D. A. STUART OIL COMPANY (G.B.) Limited, has been formed as a wholly owned subsidiary of the Amber Group of Companies. The new company has been set up to market in this country the products of D. A. Stuart Oil Company Limited of Chicago and Toronto, widely known in North America as producers of metal working lubricants since 1865. Sales director of the new company is Mr. R. F. Middleton.

POROUS PLASTICS LIMITED has been formed to handle the manufacture and marketing of Vyon, the microporous plastic material introduced by Pritchett & Gold and E.P.S. Company Limited. The address of the new company is Dagenham Dock, Essex.

S. SMITH AND SONS (ENGLAND) LIMITED announce the formation of a new division to integrate its business in industrial products, which have hitherto been made or marketed by Smiths Industrial Instruments Limited, Kelvin & Hughes (Industrial) Limited, and David Harcourt Limited with the trading style "Smiths Industrial Division". General manager of the new division will be **Mr. W. M. Cann,** who has been general manager of Smiths Industrial Instruments Limited since May, 1955. The head office of the new division will be: Chronos Works, North Circular Road, London NW2.

Contracts and Work in Progress

BRUSH ELECTRICAL ENGINEERING COMPANY LIMITED, Loughborough—46 Type-2 diesel electric locomotives for British Railways.

HANCOCK & COMPANY (ENGINEERS) LIMITED, Croydon—Oxygen cutting machinery value approx £30,000 for the Linde Company division of Union Carbide Corporation of the U.S.A. for supply to a number of American companies.

HONEYWELL CONTROLS LIMITED.—Instrumentation worth £200,000, for a Russian chemical works, being built by Vickers-Armstrongs (Engineers) Limited to the design of Zimmer's, of Frankfurt.

WILLIAM BOBY & CO. LIMITED, Rickmansworth.—Contract valued at £5,480 from Messrs. Hickson & Welch of Castleford, Yorks, for a base exchange plant and deaerator for their new boilers.

Contract valued at approx. £4,200 for electrodialytic desalting plant for Iraq Petroleum Company.

ENGLISH ELECTRIC COMPANY LIMITED.—Diesel-electric propulsion installation costing about £400,000 for the new Cook Strait Ferry. The ferry has been ordered from Wm. Denny & Brothers of Dumbarton by the New Zealand Government Railways.

Rectifiers and transformers worth about £500,000 for Hindustan Aluminium Corporation.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED, Switchgear Division.—Switching station, value £500,000 approx., at Brinsworth, near Sheffield, which will provide for the new steelworks projects in the area. Switchgear associated with the experimental 380-kV working of a transmission line between High Marnham and Monk Fryston. Both orders from the Central Electricity Generating Board.

Transformer Division: 20 ft 180-kW infra-red oven for drying cellulose paint, for Vauxhall Motors Limited.

Heavy Plant Division: Order worth about £700,000 for electrical equipment for a new rod mill from the Broken Hill Proprietary Company Limited, Australia.

ASSOCIATED ELECTRICAL INDUSTRIES (N.Z.) Limited.—20 sets of power equipment, including diesel engines, for 420-hp diesel-electric locomotives for the New Zealand Government Railways.

SOLARTRON ELECTRONIC GROUP LIMITED, Farnborough, Hants.—contract to provide the instrumentation and control apparatus for the next major experiment for controlled thermo-nuclear research.

SOLARTRON RADAR SIMULATORS LIMITED.—Radar simulating systems, value approximately £200,000 for the Swedish Government.

PERKINS ENGINES LIMITED, Peterborough.—400 Four 99 diesel engines for Droningborg Maskinfabric A/S of Randers, Denmark.

WESTINGHOUSE BRAKE AND SIGNAL COMPANY Limited.—Silicon rectifier equipment, rated at 50,000A at 200V, for Murgatroy's Salt & Chemical Company Limited at Sandbach. Silicon rectifier equipment rated at 25,000A at 40V for chloride production for water purification in Kuwait. The electrolytic cells and other chemical equipment are here provided by Messrs. Krebs of Switzerland.

GEORGE COHEN, SONS & COMPANY LIMITED. Dismantling and disposal of the plant and buildings of the former Normanby Ironworks, Middlesborough.

HEENAN & FROUDE LIMITED, Worcester.—Two standard lubricating oil test rigs, one for the Ministry of Aviation and another for the Swiss Federal Government Laboratory.

Long Service Awards

FORTY-SEVEN men who had completed 40 years' service with the Hoffmann Manufacturing Company Limited, and seven women with 35 years' service were the recipients of gifts at the 14th annual presentation on June 21. Additional holidays and cash awards upon an increasing scale are made for 10, 20, 30 and 40 years' service.

After Sales Service

AN optional service scheme covering their full range of lifting magnets has been instituted by Rapid Magnetic Limited. It is called the Service Contract and provides for visits, at agreed intervals, of qualified service engineers.

Washing Facilities

FACTORY owners and occupiers in Great Britain will be required, from the beginning of this month, to provide running hot and cold or warm water among washing facilities for workers. Until August 1 of next year factories employing five workers or less are exempt.

Temperature Measurement

Practically every sphere of manufacture or processing involves the application of heat. This heat has to be correctly regulated and a new leaflet from George Kent Limited describes some of the instruments manufactured by this company for temperature measurement. These consist of indicators, recorders and controllers, all having potentiometers, maximum visibility scale (in self-balancing instruments) of size 10 in., and automatic cold-junction temperature compensation. Fuller information, with details of after-sales service, is given in a new folder obtainable from George Kent Limited, Luton, Bedfordshire.

Box Furnaces

The Metalectric standard range of P.T. furnaces has been developed for a wide variety of heat treatment processes and basically for operating temperatures up to 1000° C. They are suited for general purpose heat treatment in the workshop and toolroom and for hardening, normalizing and annealing. P.T. furnaces can be adapted for other duties and with slight constructional modifications may be made suitable for pack carburizing and heat treatments under controlled atmosphere conditions. Leaflet No. M4b available from the manufacturers, Metalectric Furnaces Limited, Cornwall Road, Smethwick 40, Staffs, contains details of the range.

Pye Scientific Instruments

The latest edition of the Pye scientific instrument catalogue describes several new developments which should interest those concerned with scientific research, industrial production, testing and process control. Among these are a stabilized power supply unit, double-reflection galvanometers, a new range of measuring microscopes and cathetometers, an argon chromatograph with new accessories, and an industrial process analyser based on this. The catalogue (N) supercedes all previous editions and copies can be obtained from W. G. Pye & Co. Limited, Granta Works, P.O. Box 60, Cambridge.

Kent Spares

A spare-parts list for the Commander Integrator (tractor-wheel type) has recently been issued by the manufacturers, George Kent Limited, Luton, Bedfordshire. Approximately two hundred separate items are listed and accompanying diagrams make identification a simple matter.

Molybdenum Disulphide

An illustrated booklet, "Molybdenum Disulphide in Action", has been published by K. S. Paul (Molybdenum Disulphide) Limited, Angel Lodge Laboratories and Works, Angel Road, London N18, who are manufacturers of the material. In addition to supplying details of the properties, important technical points, and extracts from relevant scientific papers, the booklet contains letters from users and reports of inspections which indicate the wide range of application. The manufacturers will send the booklet free to anyone interested.

Lighting Louvres

A range of attractive louvres for use with fluorescent lighting is available from Courtney Pope (Electrical) Limited. Made from plastic material, they are light in weight, have colour stability, and give high value of illumination. They are supplied in standard sizes or tailor-made to individual requirements. A descriptive leaflet can be obtained from Courtney Pope (Electrical) Limited, Amhurst Park Works, Tottenham, N15.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Beryllium Copper Crinkle Washers

The beryllium copper crinkle washer has been developed as an improved spring washer, for particular use in the manufacture of all types of precision instruments, applicable to such industries as radar, television, aircraft, wireless and the electrical trade generally. Fabricated from beryllium copper strip, the washer is subjected to heat treatment and plating. It is 100% corrosion free. The makers, Thomas Haddon and Stokes Limited, Deritend, Birmingham 12, supply a leaflet giving details.

Alloy Steel

The outstanding feature of Helca 174, an alloy steel manufactured by Hadfields Limited, is its ability to withstand alternate heating and cooling without the occurence of the crazing associated with heat shock, a characteristic rendering it particularly suitable for applications where operating conditions demand rapid cooling between operations. Further features are its low notch sensitivity and ability to air-harden in heavy section. Other details are given in a leaflet supplied by Hadfields Limited, East Hecla Works, Sheffield 9.

Tornado Fans

A new, larger edition of Keith Blackman's "Heavy Fan Engineering" booklet (Publication No. 25, 24 pages), has now been published and is freely available from the Publicity Department, Mill Mead Road, London N17. (Telephone Tottenham 4522, Ext. 310). This booklet shows the scope of the Tornado range of fan engineering equipment in the large and heavy sizes. Individual sections deal with centrifugal and axial fans, blowers and exhausters, ancillary equipment such as air heaters, dust exhaust and collecting plant, and metal structure and fabrications. A further section provides a brief survey of the manufacturing facilities available at the three Keith Blackman Works at Tottenham and Edmonton, London, and Arbroath in Scotland.

Road Vehicle Lubrication

"Road Vehicle Lubrication" is the title of a 76 page handbook just published by Wakefield-Dick Industrial Oils Limited, a member of the Castrol Group of Companies. It offers a comprehensive guide to the commercial operator of both passenger and goods vehicles on the proper lubrication maintenance of engine transmission and final drive. There are also chapters on chassis lubrication, the effects of faulty lubrication and equipment and oil storage. Copies are available free on request to Wakefield-Dick Industrial Oils Limited, Castrol House, Marylebone Road, London NW1.

Soldering Fluids

Technical Information Sheets are available from Perdeck Solder Products Limited, Abbey Mills, Watham Abbey, Essex, on a group of special purpose tinning and soldering fluxes. "Weem-45" is a crystalline penetrating flux for the ends of flexible shafts; "Weem-101" a liquid flux for copper and brass, with a complementary concentrate form; "Paste-flux" a general purpose flux, and "Weem No. 1" a liquid flux for nickel-plated objects, type bars, etc.

Bag Filters

The Holmes-Retroflux bag filter (system Junkmann) has numerous advantages for those applications where high dust burdens are encountered and/or dusts of an adhesive nature. Sectional drawings of the plant and details of the operating principle are set out in a new folder issued by W. C. Holmes & Co. Limited, Turnbridge, Huddersfield.

Boiler Dust Control

The emission of corrosive and greasy black particles, and the corrosion of flues and stacks in oil-fired installations has been worrying many users for a long time. Dust Control Processes have now been successful in developing a system to overcome this problem. The basis of the system is the injection, by means of the Insufflator, of a controlled concentration of finely divided alkaline hygroscopic precipitate, the particles of which provide nuclei for the adsorption of acid and fine greasy particles. A brochure giving details of the system is available from Dust Control Processes Limited, 161 Clarence Street, Kingston-upon-Thames.

Bedlington. Thermalite Ytong, Limited, a London subsidiary of John Laing and Sons Limited, are to erect a factory at Cambois for the making of lightweight steam cured aerated concrete. The factory will use pulverized fuel ash from the nearby Cambois power station, and when completed will employ 300 men.

Billingham-on-Tees. Imperial Chemical Industries Limited are to erect drawing offices of about 28,000 sq ft and laboratory (40,000 sq ft) at their Billingham Works.

Chester-le-Street. J. L. Hawk. The architects for a proposed small glazing factory and office in Station Road are Fennell and Baddily, Bridge End Chambers, Chester-le-Street.

Darlington. J. M. and J. Bartlett Limited, builders' merchants, Lombard House, Warwick Street, Newcastle upon Tyne, are considering the erection of showroom, offices, and warehouse at Houndgate, Darlington, but it is not expected that the work will be proceeded with at present. The architects are Wetherell, Lamb and Partners, 42 Victoria Road, Darlington.

Durham. Fowler and Armstrong Limited, motor engineers etc., New Elvet, Durham, are to use 2000 sq ft of land at Elvet Station for the servicing of cars. The architects are Cordingley and McIntyre, Owengate, Durham.

Hebburn (Co. Durham). Pryotenax Limited, cable manufacturers, are to extend their factory to cope with increased business.

Houghton-le-Spring. The Durham Divisional Coal Board, Milburn House, Newcastle upon Tyne, are to erect engine sheds at New Herrington.

Jarrow. The Town Council is considering the erection of a 35,000 sq ft factory fronting on to the River Tyne, to be let to a Lincolnshire firm. Plans are by the borough engineer (H. W. T. Perkins). The Corporation intends proceeding with the work as soon as possible.

Middlesbrough. Dorman Long and Company (Steel) Limited are to spend nearly £7,000,000 on the construction of a 360 ton tilting open-hearth furnace, and a 600 ton mixer at Lackenby Steelworks, and a third blastfurnace at Cleveland Works. The work will be carried out by Dorman Long's group of companies.

Newcastle upon Tyne. Hutchinson and Company Limited, engineers etc., Back Duke Street, are to erect three storey factory and offices to plans by M. and H. Gatoff, 26 Mosley Street, Newcastle.

David Landau Limited, scrap metal merchants, Heber Street, propose a warehouse in Skinnerburn Road. The architects are Tarren and Caller, 16 Great North Road, Newcastle.

Shildon (Co. Durham). Durworth Limited, Church Street, Shildon, are to use former Eldon Schools as a clothing factory.

The Urban District Council is seeking planning permission to schedule a site of 12·3 acres at Dale Road, Shildon, for proposed factory purposes.

Sunderland. Ericsson Telephones Limited. The contract for factory extensions has been let to D. Glen Limited, Albert Road, Jarrow.

Tynemouth. Foots Limited, boxmakers. Additions proposed at Foots Buildings, North Shields.

G. S. Robinson and Company Limited. Extensions are proposed to sheet metal works at Clive Street. The architects are Wood and Pigg, 17a, Northumberland Square, North Shields.

Thornaby-on-Tees. J. Hamilton. Plans for bakery extension in Thornaby Road have been prepared by Tarren and Caller, 24 Front Street, Sedgefield.

D. C. Wiggins (Engineers) Limited. The architect for proposed workshop extensions in Mann Street is H. Cowan, 20 Finkle Street, Stockton.

W. and M. Pumphrey Limited, Archer Street, Thornaby, propose car showrooms and service station in Mandale Road. Outline plans are being considered by the planning authority.

Wallsend. Swan Hunter and Wigham Richardson Limited. Plans have been approved for reconstructing building berth at the Wallsend Shipyard. The consulting engineers are T. F. Burns and Partners, 3 Ellison Place, Newcastle upon Tyne.

Abergavenny. Cooper's Mechanical Joints Limited, Llanfoist Works, are to extend their works.

New Factories

Birmingham. L. & O. Hammett Limited, 81 New John Street, have been granted permission to erect a new factory.

Blackburn. J. S. Duxbury & Son Limited, Atlas Paper Works, River Street, Works extensions.

Cobble Bros. Machinery Company Limited. Extensions to factory in Gate Street.

Blackpool. Sunnytoys Limited, Cowley Road are to extent their factory.

Bootle. James Welsh & Sons Limited have applied for permission to make extensions to their factory in Cedar Street.

Brighouse. Stereosound Productions Limited. Extensions to be made to the works in Wood Street.

Burnley. Burnley Aircraft Products Limited, Britannia Mill, Ruskin Street, are to extend their factory.

T. Foster Limited. Extensions are to be made to Habergham Mill, Coal Clough Lane.

Coventry. Torrington Company Limited, Torrington Avenue. Factory extensions.

Alfred Herbert Limited are to erect an alloy melting plant at their works in Cross Road.

Dagenham. Lewis Berger (Great Britain) Limited, Freshwater Road. Factory extensions.

Dewsbury. Newlay Concretes Limited, Thornhill Works, Calder Road, are to erect an engineers' shop.

Doncaster. British Ropes Limited, Carhill, Balby. £2 million is to be spent over the next five years on extensions to plant.

Enfield. Tobex Paint Company Limited are to extend their factory at Southbury Road.

Halifax. John Mackintosh & Sons Limited, Albion Mills, are to erect a new factory.

Havant. Tampax Limited, Dunsbury Way, Leigh Park. Permission has been received to extend the factory.

Hemel Hempstead. Hemel Hempstead Engineering Company Limited. The architects for works extensions are Wallis, Gilbert & Partners, 8 Cromwell Road, London SW7.

Hoddesdon. Merck-Sharp & Dohme Limited, West Hill. Plans have been approved for extensions to the factory.

Liverpool. The Davies Tyre Company Limited, Davies Works, The Hyde, London NW9, are to erect a new factory at Kirkby.

Lowestoft. Yarecroft Marine (Lowestoft) Limited are seeking a suitable site for a new factory.

Manchester. Joseph Crewe & Co. Limited, Crabtree Lane, Clayton. The paper works is to be extended.

Margate. G. A. Harvey Limited, Ramsgate Road. Extensions to factory.

Nuneaton. Union Wool & Leather Company Limited. Extensions are to be made to the factory in Church Street.

Paisley. Pressed Steel Company Limited are to extend their works at Linwood.

Perivale. Suflex Limited, 35 Baker Street, London W1. The architect for factory extensions is F. L. Marcus, 12 Bedford Square, London WC1.

Plymouth. Griffin & George (Scientific Instruments) Limited, Frederick Street, Birmingham. A new factory and offices is to be built at Burrington industrial estate. The architects are A. French & Partners, Pearl Assurance House, Royal Parade, Plymouth.

Portsmouth. Bettix Limited are to extend their factory in Rodney Road.

Rushden. H. W. Chapman Limited, Oliver Cromwell Road. The factory in Oak Street is to be extended.

Shipley. Moore Johnson Limited, 154–6 Sunbridge Road, Bradford. New factory.

Southampton. Mullard Radio Valve Company Limited. Extensions to factory.

Stalybridge. Range Boilers Limited, Bridge Street, are to make extensions to their factory.

Wakefield. Hepburn Conveyor Company Limited. The factory in Ings Road is to be extended.

Watford. A. A. Polishers & Platers, Loates Lane, are to erect a new factory on the Holywell Estate.

Extensions are to be made to the factory off Chalk Hill for Mark Anthony & Sons Limited.

Wigan. Edmund Taylor Limited. Extensions are to be made to the factory at Skull House Lane.

Wokingham. A. Johnson (London) Limited, Villiers House, Strand, London WC2. Plans have been approved for the erection of a new factory and offices.

Arbroath. Braemar Knitwear Limited of Hawick are to extend their subsidiary factory at Arbroath.

Ayr. Scottish Agricultural Industries Limited of Newton on Ayr have received approval for alterations to their reception areas and sidings at a cost of £5000.

McGill and Smith Limited of York Street Lane, Ayr, are to make alterations to their loading bay and to add new processing machinery.

Paisley. A. F. Stoddard and Company Limited of Paisley, carpet manufacturers have received approval for a £25,000 extension to their Wellington Street Works.

Whitburn. Highland Engineering Limited are to undertake industrial and commercial developments at Whitburn, with two factories on the Whitburn–Edinburgh–Glasgow Road.

Dunlop Rubber Company Limited is negotiating for a 100,000 sq ft factory adjacent to the B.M.C. tractor and commercial vehicle plant now under construction at Bathgate.

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Patents For Sale or License

THE proprietor of British Patent No. 637940, entitled "Tube Coupling Sleeve" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn St. Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 777885, entitled "Plug valve", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn St., Chicago 3, Illinois, U.S.A.

THE proprietors of patent No. 774975 for "Improvements in or relating to Machine Tools" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co. 28, Southampton Buildings, Chancery Lane, London WC2.

THE proprietors of patent No. 774976 for "Improvements in or relating to Machine Tools" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London WC2.

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THE proprietors of patent No. 774977 for "Improvements in or relating to Machine Tools" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London WC2.

THE proprietors of patent No. 761609 for "Electronic Devices for the Operation of a Time Piece Movement" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 707617, entitled "Ejecting mechanism for punch presses", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn St., Chicago 3, Illinois, U.S.A.

THE Proprietors of Patent No. 671413 for "Slings for lifting and lowering or for forming bundles" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London WC2.

Situations Vacant

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Candidates for Inspectors of Works (Mechanical) should be fully experienced in the operation maintenance and overhaul of all kinds of road construction plant, and commercial vehicles of all types. Experience should include machine shop practice as particularly applied to overhaul of petrol and compression ignition engines and automobile electrical apparatus. Preference may be given to candidates possessing a City and Guilds certificate in vehicle technology.

For Inspectors of Works (Water) candidates are required to have a recognised apprenticeship as plumber, fitter or pipe layer with at least five years' experience in water supply schemes. Possess considerable experience in water Supply Corporation or Water Works operation and maintenance will be accepted in lieu of apprenticeship.

Salary will depend on qualifications and experience and will be in the range of £906–£1554 per annum. Generous leave with full pay and other allowances are also payable.

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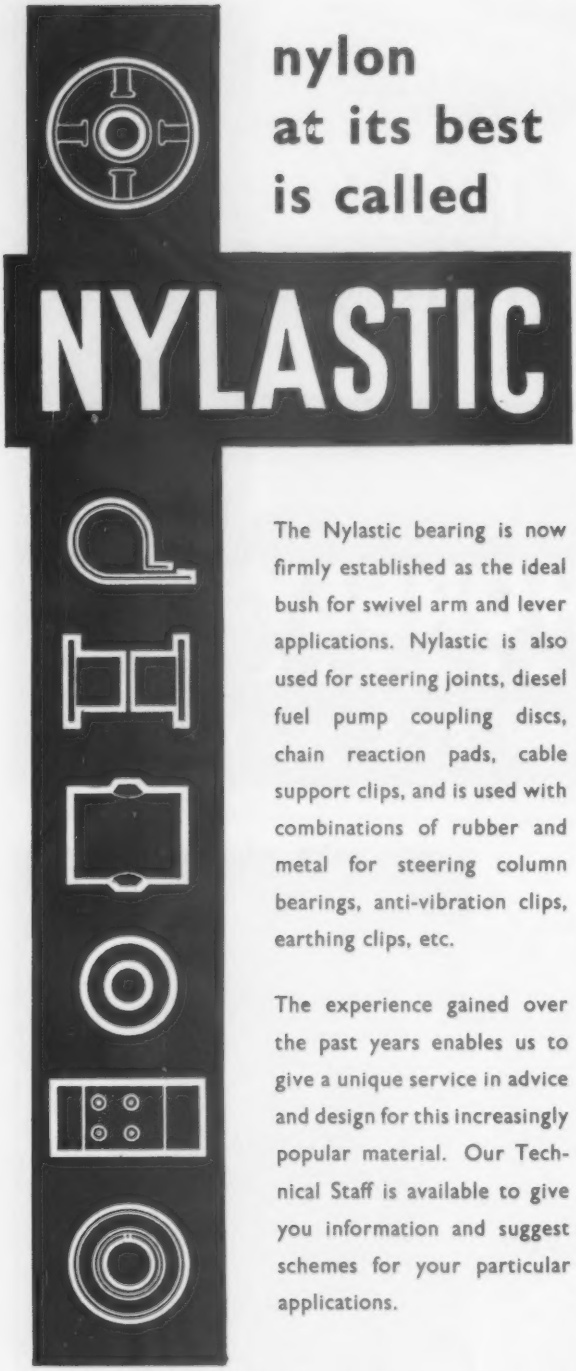

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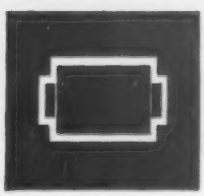

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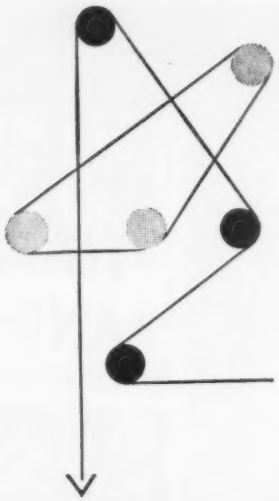

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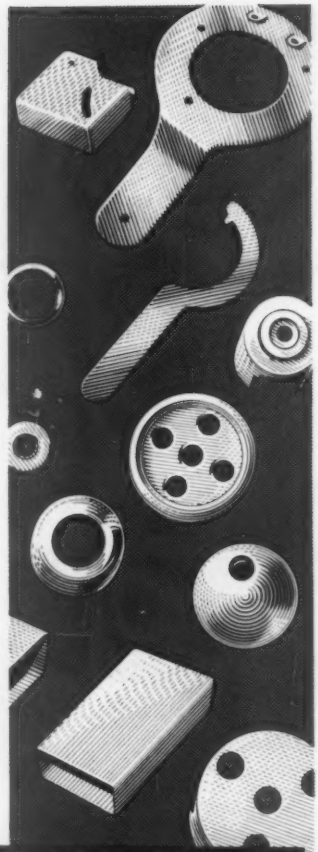

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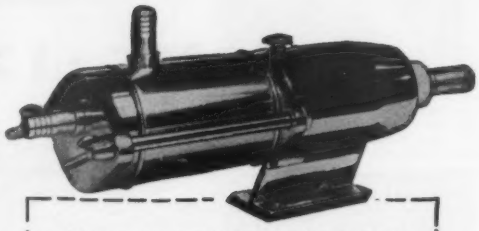

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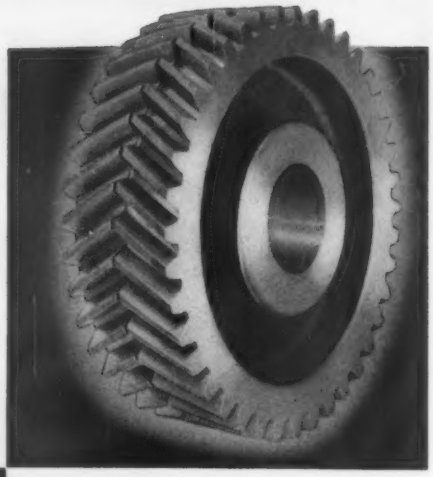

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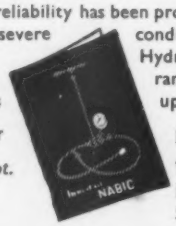

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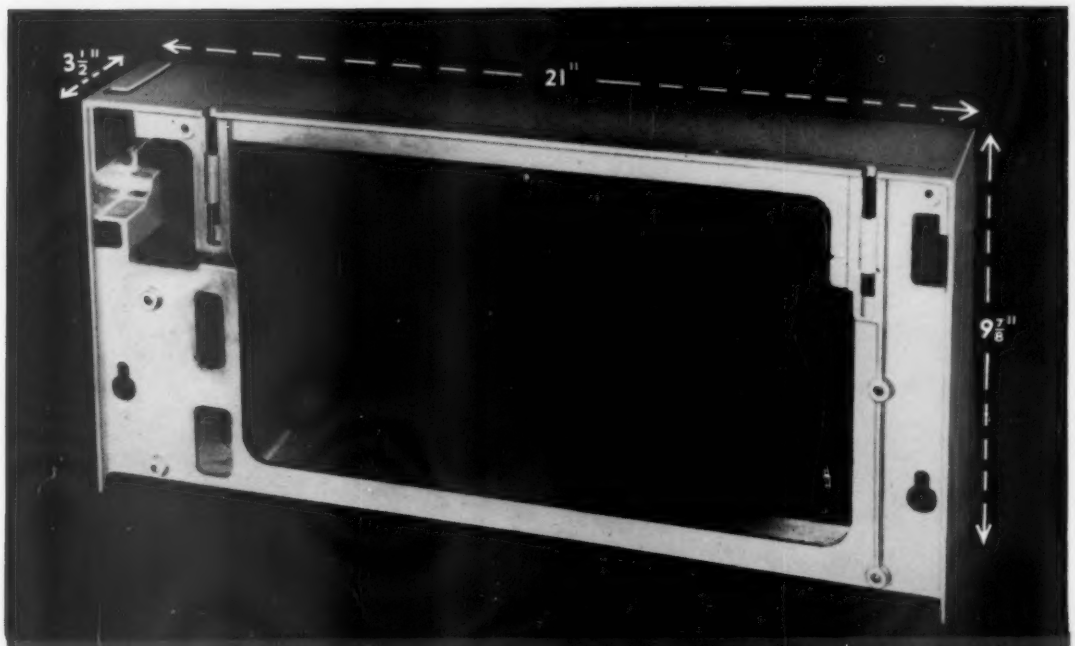

Main grill frame (finished weight 4.20 lbs. Cast by the Birmingham Aluminium Casting (1920) Co., Ltd., using KE A. 145 steel die). Photograph by courtesy of Cannon Industries Ltd.

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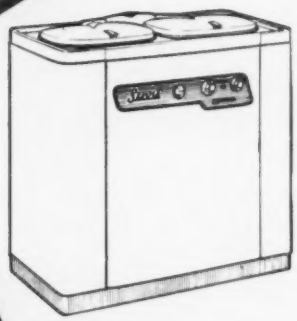

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